UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	ADP-231 (SP05-073)	Total Pages	2
First Named Inventor or Application Identifier: Adam J.G. Ellison			
Title : FINING OF BOROALUMINO SILICATE GLASSES			
Express Mail Label No.	EV327193183US		

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on June 28, 2006 (Date)

Signature _____ Thomas R. Beall

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1. ☒ * Fee Transmittal Form
   (Submit an original and a duplicate for fee processing)
2. ☒ Specification [*Total Pages* 33]
   (preferred arrangement set forth below)
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R&D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings (if filed)
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. ☒ Drawing(s) *(35 U.S.C. § 113)* [*Total Sheets* 3]
4. Oath or Declaration [*Total Pages* 2]
   a. ☒ Executed (original or copy)
   b. ☐ Copy from a prior application (37 C.F.R. § 1.63(d)) *(for continuation/divisional with Box 16 completed)*
      i. ☐ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).
5. ☐ Microfiche Computer Program *(Appendix)*
6. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. ☐ Computer Readable Copy
   b. ☐ Paper Copy (identical to computer copy)
   c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. ☒ Assignment Papers (cover sheet & document(s))
8. ☒ 37 C.F.R. § 3.73(b) Statement ☒ Power of Attorney *(when there is an assignee)*
9. ☐ English Translation Document *(if applicable)*
10. ☒ Information Disclosure Statement (IDS)/PTO-1449 ☒ Copies of IDS Citations
11. ☐ Preliminary Amendment
12. ☒ Return Receipt Postcard (MPEP 503) *(should be specifically itemized)*
14. ☐ Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
15. ☐ Other:

16. **If a CONTINUING APPLICATION**, *check appropriate box, and supply the requisite information below and in a preliminary amendment:*

☐ Continuation ☐ Divisional. ☐ Continuation-in-part (CIP) of prior application No

Prior application information: *Examiner:* *Group / Art Unit:*

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

☒ *Customer Number or Bar Code Label* 22928 *or* ☐ *Correspondence address below*

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Signature			Date	June 28, 2006	

Corning Incorporated EX2005
IPR2025-00937
U.S. Patent No. 8,640,498

FEE TRANSMITTAL for FY 2005

Complete if Known	
Application Number	To Be Assigned
Filing Date	Herewith
First Named Inventor	Adam J.G. Ellison
Examiner Name	To Be Assigned
Group / Art Unit	To Be Assigned
Attorney Docket Number	ADP-231 (SP05-073)

TOTAL AMOUNT OF PAYMENT	($)1,000.00

METHOD OF PAYMENT (check one)

1. ☒ The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

Deposit Account Number: 03-3325

Deposit Account Name: Corning Incorporated

☒ Charge Any Additional Fees Required Under 37 C.F.R. §§ 1.16 and 1.17

2. ☐ **Payment Enclosed:**
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FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEE

Application Type	Filing Fee	Search Fee	Exam Fee	Fee
Utility	300	500	200	1,000.00
Design	200	100	130	
Plant	200	300	160	
Reissue	300	500	600	
Provisional	200	0	0	
SUBTOTAL (1)				($)1,000.00

2. EXCESS CLAIM FEES

	Extra Claims	Fee from below	Fee Paid
Total Claims	20 - 20** =	0 x 50 =	00.00
Independent Claims	3 - 3** =	0 x 200 =	00.00
Multiple Dependent		360 =	0.00

***or number previously paid, if greater; For Reissues, see below*

Large Fee Code	Entity Fee ($)	Fee Description
1202	50	Claims in excess of 20
1201	200	Independent claims in excess of 3
1203	360	Multiple dependent claim, if not paid0
1204	200	** Reissue independent claims over original patent
1205	50	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($)00.00

FEE CALCULATION (continued)

3. APPLICATION SIZE FEE

1081	250	Utility application size fee (for each additional 50 sheets that exceeds 100 pages)
1082	250	Design application size fee (for each additional 50 sheets that exceeds 100 pages)
1083	250	Plant application size fee (for each additional 50 sheets that exceeds 100 pages)
1084	250	Reissue application size fee (for each additional 50 sheets that exceeds 100 pages)
1085	250	Provisional application size fee (for each additional 50 sheets that exceeds 100 pages)

4. OTHER FEES

Fee Code	Fee ($)	Fee Description	Large Entity Fee Paid
1051	130	Surcharge - late filing fee or oath	
1052	50	Surcharge - late provisional filing fee or cover sheet	
1053	130	Non-English specification	
1812	2,520	For filing a request for reexamination	
1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	Requesting publication of SIR after Examiner action	
1251	120	Extension for reply within first month	
1252	450	Extension for reply within second month	
1253	1,020	Extension for reply within third month	
1254	1,590	Extension for reply within fourth month	
1255	2,160	Extension for reply within fifth month	
1401	500	Notice of Appeal	
1402	500	Filing a brief in support of an appeal	
1403	1,000	Request for oral hearing	
1451	1,510	Petition to institute a public use proceeding	
1452	500	Petition to revive - unavoidable	
1453	1,500	Petition to revive - unintentional	
1501	1,400	Utility issue fee (or reissue)	
1502	800	Design issue fee	
1503	1,000	Plant issue fee	
1462	400	Petitions to the Director not specifically provided for (Group I) 1.17(f)	
1463	200	Petitions to the Director not specifically provided for (Group II) 1.17(g)	
1464	130	Petitions to the Director not specifically provided for (Group III) 1.17(h)	
1807	50	Petitions related to provisional applications	
1806	180	Submission of Information Disclosure Stmt	
8021	40	Recording each patent assignment per property (times number of properties)	
1809	790	Filing a submission after final rejection (37 C.F.R. § 1.129(a))	
1810	790	For each additional invention to be examined (37 C.F.R § 1.129(b))	
1801	790	Request for Continued Examination (RCE)	
1802	900	Request for expedited examination of a design application	

*Reduced by Basic Filing Fee Paid SUBTOTAL (3) ($)

SUBMITTED BY		Completed (if applicable)	
Name (Print/Type)	Thomas R. Beall	Registration No. (Attorney/Agent)	40,424
Signature		Date	June 28, 2006

PATENT
ATTORNEY DOCKET: ADP-231 (SP05-073)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Adam J.G. Ellison

AUTHORIZATION TO ACT IN A REPRESENTATIVE CAPACITY

Serial No.:

Group Art Unit: TBA

Filed:

For: FINING OF BOROALUMINO SILICATE GLASSES

Examiner: TBA

COMMISSIONER FOR PATENTS
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AUTHORIZATION TO ACT IN A REPRESENTATIVE CAPACITY

The practitioner named below is authorized to conduct interviews and has the authority to bind the principal concerned. Furthermore, the practitioner is authorized to file correspondence in the above-identified application pursuant to 37 CFR 1.34:

Name:	Maurice M. Klee, Ph.D.
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This is not a Power of Attorney to the above-named practitioner. Accordingly, the practitioner named above does **not** have authority to sign a request to change the correspondence address, a request for an express abandonment, a disclaimer, a power of attorney, or other documents requiring the signature of the application, assignee of the entire interest or an attorney of record. If appropriate, a separate Power of Attorney to the above-identified named practitioner should be executed and filed in the United States Patent and Trademark Office.

June 28, 2006
Date

SIGNATURE OF PRINCIPAL ATTORNEY OF RECORD
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FINING OF BOROALUMINO SILICATE GLASSES

I. CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Application Serial No. 60/694,478 filed on June 28, 2005 and entitled "Fining of Boroalumino Silicate Glasses" which is incorporated by reference herein in.

II. FIELD OF THE INVENTION

The present invention relates to alkali-free, boroalumino silicate glasses exhibiting desirable physical and chemical properties for use as substrates in flat panel display devices, such as, active matrix liquid crystal displays (AMLCDs). In accordance with certain of its aspects, the invention relates to the fining of such glasses (also referred to in the art as "refining").

III. BACKGROUND OF THE INVENTION

Displays may be broadly classified into one of two types: emissive (e.g., CRTs and plasma display panels (PDPs)) or non-emissive. This latter family, to which liquid crystal displays (LCDs) belong, relies upon an external light source, with the display only serving as a light modulator. In the case of liquid crystal displays, this external light source may be either ambient light (used in reflective displays) or a dedicated light source (such as found in direct view displays).

Liquid crystal displays rely upon three inherent features of liquid crystal (LC) materials to modulate light. The first is the ability of LC materials to cause optical rotation of polarized light. Second is the dependence of such rotation on the

mechanical orientation of the liquid crystal. And third is the ability of the liquid crystal to undergo mechanical orientation by the application of an external electric field. In the construction of a simple, twisted nematic (TN) liquid crystal display, two substrates surround a layer of liquid crystal material. In a display type known as Normally White, the application of alignment layers on the inner surfaces of the substrates creates a 90° spiral of the liquid crystal director. This means that the polarization of linearly polarized light entering one face of the liquid crystal cell will be rotated 90° by the liquid crystal material. Polarization films, oriented 90° to each other, are placed on the outer surfaces of the substrates.

Light, upon entering the first polarization film becomes linearly polarized. Traversing the liquid crystal cell, the polarization of this light is rotated 90° and is allowed to exit through the second polarization film. Application of an electric field across the liquid crystal layer aligns the liquid crystal directors with the field, interrupting its ability to rotate light. Linearly polarized light passing through this cell does not have its polarization rotated and hence is blocked by the second polarization film. Thus, in the simplest sense, the liquid crystal material becomes a light valve, whose ability to allow or block light transmission is controlled by the application of an electric field.

The above description pertains to the operation of a single pixel in a liquid crystal display. High information type displays require the assembly of several million of these pixels, which are referred to in the art as sub pixels, into a matrix format. Addressing all of these sub pixels, i.e., applying an electric field to all of these sub pixels, while maximizing addressing speed and minimizing cross-talk presents several challenges. One of the preferred ways to address sub pixels is by controlling the electric field with a thin film transistor located at each sub pixel, which forms the basis of active matrix liquid crystal display devices (AMLCDs).

The manufacturing of these displays is extremely complex, and the properties of the substrate glass are extremely important. First and foremost, the glass substrates used in the production of AMLCD devices need to have their physical dimensions tightly controlled. The downdraw sheet drawing processes and, in particular, the fusion process described in U.S. Patents Nos. 3,338,696 (Dockerty) and 3,682,609 (Dockerty), is one of the few processes capable of delivering glass sheets which can be used as

substrates without requiring costly post forming finishing operations, such as lapping and polishing. Unfortunately, the fusion process places rather severe restrictions on the glass properties, requiring relatively high liquidus viscosities, preferably greater than 100,000 poises, more preferably, greater than 150,000 poises.

Typically, the two plates (substrate assemblies) that comprise a flat panel display are manufactured separately. One, the color filter plate, has a series of red, blue, green, and black organic dyes deposited on it. Each of these primary colors must correspond precisely with a sub pixel of the companion active plate. To remove the influence of differences between the ambient thermal conditions encountered during the manufacture of the two plates, it is desirable to use glass substrates whose dimensions are independent of thermal condition (i.e., glasses with lower coefficients of thermal expansion). However, this property needs to be balanced by the generation of stresses between deposited films (e.g., silicon films) and the substrates that arise due to expansion mismatch. It is estimated that an optimal coefficient of thermal expansion (CTE) is in the range of 28-34 $x10^{-7}$/°C (0-300°C), more preferably, 28-33 $x10^{-7}$/°C (0-300°C).

The active plate, so called because it contains the active, thin film transistors, is manufactured using typical semiconductor type processes. These include sputtering, CVD, photolithography, and etching. It is highly desirable that the glass be unchanged during these processes. Thus, the glass needs to demonstrate both thermal stability and chemical durability.

Thermal stability (also known as thermal compaction or shrinkage) is dependent upon both the inherent viscous nature of a particular glass composition (as indicated by its strain point) and the thermal history of the glass sheet as determined by the manufacturing process. U.S. Patents Nos. 5,374,595 (Dumbaugh et al.) and 6,319,867 (Chacon et al.) disclose glasses with strain points in excess of 650°C which, when subjected to the thermal history of the fusion process, have acceptable thermal stability for active plates based both on a-Si thin film transistors (TFTs) and super low temperature p-Si TFTs. Higher temperature processing (such as required by low temperature p-Si TFTs) may require the addition of an annealing step to the glass substrate to ensure thermal stability.

Chemical durability implies a resistance to attack by the various etchant solutions used in the manufacture processes. Of particular interest is a resistance to attack from the dry etching conditions used to etch the silicon layer. To benchmark the dry etch conditions, a substrate sample is exposed to an etchant solution known as 110BHF. This test consists of immersing a sample of glass in a solution of 1 volume of 50 wt.% HF and 10 volumes 40 wt.% NH_4F at 30°C for 5 minutes. The sample is graded on weight loss and appearance. In addition to the 110BHF test, glass substrates are also tested for their resistance to acid conditions. In this case, the etchant solution is 5% HCl and the glass sample is immersed in the test solution for 24 hours at 95°C.

In addition to these requirements, AMLCD manufacturers are finding that both demand for larger display sizes and the economics of scale are driving them to process larger sized pieces of glass. Current industry standards are Gen VI (1500mm x 1850mm) and Gen VII (1870mm x 2200mm), but future efforts are geared toward even larger sizes in excess of 2 meters on each side. This raises several concerns.

First is simply the weight of the glass. The increase in glass weight in going from one generation to the next has significant implications for the robotic handlers used to ferry the glass into and through process stations. In addition, elastic sag, which is dependent upon glass density and Young's modulus, becomes a particularly critical issue with larger sheet sizes, impacting the ability to load, retrieve, and space the glass in the cassettes used to transport the glass between process stations.

In addition to the weight and sag problems, the increasing sizes of substrates leads to greater challenges in terms of manufacturing defect-free glass sheets. Because of the small sizes of sub pixels, substrates used for display applications must be essentially completely defect free.

One of the primary sources of defects is gaseous inclusions (also known as "seeds") resulting from entrapment of air in the molten glass as batch materials are melted. Historically, such gaseous inclusions have been removed through the use of arsenic as a fining agent. However, arsenic raises environmental and health issues, and thus there has been a continuing effort in the art to produce glasses with lower arsenic levels and, preferably, glasses which are substantially arsenic free. U.S. Patent Nos. 5,785,726 (Dorfeld et al.) 6,128,924 (Bange et al.) 5,824,127 (Bange et al.) and co-

pending patent application Serial No. 11/116,669 disclose processes for manufacturing arsenic free glasses.

Efforts have been made to replace arsenic fining with antimony fining. However, antimony has its own environmental and health issues. Also, compared to arsenic, antimony is a less effective fining agent.

In quantitative terms, the gaseous inclusion level in commercially produced glass sheets needs to be less than or equal to 0.10 gaseous inclusions/cm^3 of glass and preferably less than or equal to 0.05 inclusions/cm^3 for sheets having a volume of at least 500 cm^3. Moreover, it is not sufficient to achieve a low level of gaseous inclusions in one or just a few glass sheets, but in order to be cost effective, glass manufacturers need to achieve the above low inclusion levels consistently. A measure of such consistency is to examine the gaseous defect level in a population of sequentially produced glass sheets, e.g., 50 sequential glass sheets. Thus, to have commercial viability, a glass intended for use as a substrate in display applications needs to achieve the above (or better) gaseous inclusion levels on average for at least 50 sequential sheets.

In view of the foregoing, it would be desirable to provide a glass composition for display devices having a low density to alleviate difficulties associated with larger sheet size, preferably less than or equal to 2.45 grams/cm^3 and a liquidus viscosity greater than or equal to 100,000 poises to allow manufacture by, for example, the fusion process. In addition, it would be desirable for the glass to have a thermal expansion coefficient (CTE) in the range of 28-34 X 10^{-7}/°C, and preferably between about 28-33 X 10^{-7}/°C, over the temperature range of 0-300°C. Furthermore, it would be advantageous for the glass to have a strain point greater than 650°C, and for the glass to be resistant to attack from etchant solutions. It would also be desirable for the glass to have a low gaseous inclusion level when commercially manufactured without the use of arsenic and/or antimony as fining agents.

IV. SUMMARY OF THE INVENTION

In accordance with a first aspect, the invention provides an alkali-free glass comprising in mole percent on an oxide basis:

SiO_2:	64.0-71.0
Al_2O_3:	9.0-12.0
B_2O_3:	7.0-12.0
MgO:	1.0-3.0
CaO:	6.0-11.5
SrO:	0-2.0 (preferably 0-1.0)
BaO:	0-0.1

wherein:

(a) $1.00 \leq \Sigma[RO]/[Al_2O_3] \leq 1.25$ (preferably, $1.03 \leq \Sigma[RO]/[Al_2O_3] \leq 1.12$), where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO; and

(b) the glass has at least one (and preferably both) of the following compositional characteristics:

(i) on an oxide basis, the glass comprises at most 0.05 mole percent Sb_2O_3;

(ii) on an oxide basis, the glass comprises at least 0.01 mole percent SnO_2.

Preferably, the glass has the further compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3.

In accordance with a second aspect, the invention provides an alkali-free glass comprising in mole percent on an oxide basis:

SiO_2:	64.0-71.0
Al_2O_3:	9.0-12.0
B_2O_3:	7.0-12.0
MgO:	1.0-3.0
CaO:	6.0-11.5
SrO:	0-1.0
BaO:	0-0.1

wherein:

$\Sigma[RO]/[Al_2O_3] \geq 1.00$ (preferably, $\Sigma[RO]/[Al_2O_3] \geq 1.03$).

Preferably, the $\Sigma[RO]/[Al_2O_3]$ ratio is less than or equal to 1.25 (more preferably, less than or equal to 1.12). Also, the glass preferably has at least one (more preferably, all) of the following compositional characteristics:

(a) on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3;

(b) on an oxide basis, the glass comprises at most 0.05 mole percent Sb_2O_3;

(c) on an oxide basis, the glass comprises at least 0.01 mole percent SnO_2.

In accordance with a third aspect, the invention provides a method for producing alkali-free glass sheets by a downdraw process (e.g., a fusion process) comprising selecting, melting, and fining batch materials so that the glass making up the sheets comprises SiO_2, Al_2O_3, B_2O_3, MgO, and CaO, and, on an oxide basis, has:

(i) a $\Sigma[RO]/[Al_2O_3]$ ratio greater than or equal to 1.0; and

(ii) a MgO content greater than or equal to 1.0 mole percent (and preferably less than or equal to 3.0 mole percent);

wherein:

(a) the fining is performed without the use of substantial amounts of either arsenic or antimony (i.e., the concentrations of As_2O_3 and Sb_2O_3 are each less than or equal to 0.05 mole percent); and

(b) a population of 50 sequential glass sheets produced by the downdraw process from the melted and fined batch materials has an average gaseous inclusion level of less than 0.05 gaseous inclusions/cubic centimeter, where each sheet in the population has a volume of at least 500 cubic centimeters.

Preferably, the glass making up the sheet is also substantially free of BaO (i.e., the concentration of BaO is less than or equal to 0.05 mole percent). Also, SnO_2 is preferably used in the fining.

In accordance with each of the foregoing aspects of the invention, the glass preferably has some and most preferably all of the following properties:

(a) a density that is less than or equal to 2.41 grams/cm^3;

(b) a liquidus viscosity that is greater than or equal to 100,000 poise;

(c) a strain point that is greater than or equal to 650°C;

(d) a linear coefficient of thermal expansion (CTE) over the temperature range 0-300 °C which satisfies the relationship:

$$28 \times 10^{-7}/°C \leq CTE \leq 34 \times 10^{-7}/°C.$$

It should be noted that the ranges specified above include the end points of the range. For example, when SiO_2 is specified to have a concentration of 64.0-71.0 mole percent on an oxide basis, the 64.0 and 71.0 values are included in the permissible values for the SiO_2 concentration. Similarly, when a concentration or other parameter is described as "being between X and Y," the X and Y values are included as part of the range.

Additional features and advantages of the invention are set forth in the detailed description which follows and, in part, will be readily apparent to those skilled in the art from that description or recognized by practicing the invention as described herein. The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitutes a part of this specification.

It is to be understood that the various features of the invention disclosed in this specification and in the drawings can be used in any and all combinations. More generally, both the above summary and the following detailed description are merely exemplary of the invention and are intended to provide an overview or framework for understanding the nature and character of the invention.

V. BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a liquidus phase diagram of the CaO-Al_2O_3-SiO_2 system.

Figure 2 is a liquidus phase diagram of the MgO-Al_2O_3-SiO_2 system.

Figure 3 shows the effect of the $\Sigma[RO]/[Al_2O_3]$ ratio on inclusions (blisters) per pound values for a multi-day experiment.

VI. DETAILED DESCRIPTION OF THE INVENTION

As discussed above, the present invention is concerned with improved glasses for use as substrates in flat panel displays, e.g., AMLCDs. In particular, the glasses meet the various property requirements of such substrates. The major components of the glass are SiO_2, Al_2O_3, B_2O_3, and at least two alkaline earth oxides, i.e., at least MgO and CaO.

SiO_2 serves as the basic glass former of the glasses of the invention. Its concentration should be greater than 64 mole percent in order to provide the glass with a density and chemical durability suitable for a flat panel display glass, e.g., an AMLCD glass, and a liquidus temperature (liquidus viscosity) which allows the glass to be formed by a downdraw process (e.g., a fusion process).

In particular, to be suitable for use in flat panel display applications, in particular, AMLCDs, the glasses of the invention preferably have a density less than or equal to 2.45 grams/cm^3 (more preferably, less than or equal to 2.43 grams/cm^3, most preferably, less than or equal to 2.41 grams/cm^3), a weight loss which is less than or equal to 0.8 milligrams/cm^2 when a polished sample is exposed to a 5% HCl solution for 24 hours at 95°C, and a weight loss of less than 1.5 milligrams/cm^2 when exposed to a solution of 1 volume of 50 wt.% HF and 10 volumes 40 wt.% NH_4F at 30°C for 5 minutes.

To be formed by a downdraw process, the glasses preferably have a liquidus viscosity which is greater than or equal to 100,000 poises, more preferably greater than or equal to 150,000 poises, and most preferably greater than or equal to 200,000 poises.

In terms of an upper limit, the SiO_2 concentration should be less than or equal to 71 mole percent to allow batch materials to be melted using conventional, high volume, melting techniques, e.g., Joule melting in a refractory melter. When the concentration of SiO_2 goes above 71 mole percent, the 200 poise temperature (melting temperature) generally rises above 1650°C, which is typically the upper limit for conventional melting processes.

Preferably, the SiO_2 concentration is between 66.0 and 70.5 mole percent, more preferably between 66.5 and 70.0 mole percent, and most preferably, between 67.0 and 69.5 mole percent. As a result of their SiO_2 content, the glasses of the invention typically have melting temperatures greater than or equal to 1600°C and less than or equal to 1650°C.

Al_2O_3 is another glass former of the glasses of the invention. An Al_2O_3 concentration greater than or equal to 9.0 mole percent provides the glass with a low liquidus temperature and a corresponding high liquidus viscosity. The use of at least 9.0 mole percent Al_2O_3 also improves the glass' strain point and modulus. In order to achieve an $\Sigma[RO]/[Al_2O_3]$ ratio greater than or equal to 1.00 (see below), the Al_2O_3 concentration needs to be kept below 12.0 mole percent. Preferably, the Al_2O_3 concentration is between 9.5 and 11.5 mole percent.

B_2O_3 is both a glass former and a flux that aids melting and lowers the melting temperature. To achieve these effects, the glasses of the invention have B_2O_3 concentrations that are equal to or greater than 7.0 mole percent. Large amounts of

B_2O_3, however, lead to reductions in strain point (approximately 10°C for each mole percent increase in B_2O_3 above 7.0 mole percent), modulus, and chemical durability.

For use in flat panel (e.g., AMLCD) applications, the glasses of the invention preferably have a strain point equal to or greater than 650°C (more preferably, equal to or greater than 655°C, most preferably, equal to or greater than 660°C), a Young's modulus equal to or greater than 10.0×10^6 psi (more preferably, equal to or greater than 10.3×10^6 psi; most preferably, equal to or greater than 10.6×10^6 psi), and a chemical durability as described above in connection with the discussion of the SiO_2 content of the glass. A high strain point is desirable to help prevent panel distortion due to compaction/shrinkage during thermal processing subsequent to manufacturing of the glass. A high Young's modulus is desirable since it reduces the amount of sag exhibited by large glass sheets during shipping and handling.

To achieve the above properties, the glasses of the invention have B_2O_3 concentrations that are less than or equal to 12.0 mole percent. Preferably, the B_2O_3 concentration is between 8.0 and 12.0 mole percent, more preferably between 8.5 and 11.5 mole percent, and most preferably, between 9.0 and 11.0 mole percent.

The Al_2O_3 and B_2O_3 concentrations are preferably selected as a pair to increase strain point, increase modulus, improve durability, reduce density, and reduce CTE, while maintaining the melting and forming properties of the glass. For example, an increase in B_2O_3 and a corresponding decrease in Al_2O_3 can be helpful in obtaining a lower density and CTE, while an increase in Al_2O_3 and a corresponding decrease in B_2O_3 can be helpful in increasing strain point, modulus, and durability, provided that the increase in Al_2O_3 does not reduce the $\Sigma[RO]/[Al_2O_3]$ ratio below 1.00. For reference, as discussed above, glasses for use in AMLCD applications preferably have CTE's (0-300°C) in the range of $28\text{-}34 \times 10^{-7}$/°C.

In addition to the glass formers (SiO_2, Al_2O_3, and B_2O_3), the glasses of the invention also include at least two alkaline earth oxides, i.e., at least MgO and CaO, and, optionally, SrO and/or BaO. The alkaline earth oxides provide the glass with various properties important to melting, fining, forming, and ultimate use.

In accordance with the invention, it has been found that the MgO concentration in the glass and the glass' $\Sigma[RO]/[Al_2O_3]$ ratio, where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO, are

critical to the glass' performance and, in particular, are critical with regard to meltability and fining.

Although not wishing to be bound by any particular theory of operation, it is believed that following aspects of glass chemistry are involved in the roles of MgO and the $\Sigma[RO]/[Al_2O_3]$ ratio in the glasses of the invention.

As is known in the art, in aluminosilicate glasses, Al^{3+} ions seek to be surrounded by four oxygen ions (O^{2-}). One means by which this occurs is traditionally called a charge-balance interaction. A silicon ion (Si^{4+}) bonded to four O^{2-} can be thought of as contributing ¼ x (+4) or an incremental charge of +1 towards the bonding requirements of each O^{2-}. If one of these oxygen ions is bonded in turn to a 4-fold coordinated Al^{3+}, then there is an additional contribution of ¼ × (+3) = +¾ towards the bonding requirements of the O^{2-} ion, for a total of +1¾. The remaining +¼ can be obtained by a nearby +2 cation such as an alkaline earth, e.g., 1/8 × (+2) = +¼. The total charge contributed by positively charged ions exactly balances the negative charge of the oxygen ions, and aluminum can remain in 4-fold coordination. The +2 cations that serve in this role are referred to as charge-balancing cations. Provided that the $\Sigma[RO]/[Al_2O_3]$ ratio is 1 or more, it then follows that nearly all aluminum in calcium aluminosilicate glasses is 4-fold coordinated by oxygen. See M Taylor, GE Brown, Structure of mineral glasses: I. The feldspar glasses $NaAlSi_3O_8$, $KAlSi_3O_8$, $CaAl_2Si_2O_8$. *Geochim. Cosmochim Acta* 43:61-75 (1979); P. McMillan, B. Piriou, A Navrotsky, A Raman spectroscopic study of glasses along the joins silica-calcium aluminate, silica-sodium aluminate, and silica-potassium aluminate. *Geochim Cosmochim Acta* 46:2021-2037 (1982); and A Navrotsky, G Peraudeau, P McMillan, JP Coutures, A thermochemical study of glasses and crystals along the joins silica-calcium aluminate and silica-sodium aluminate. *Geochim Cosmochim Acta* 46:2039-2047 (1982). As is also known in the art, the efficacy of charge-balance by +2 cations varies inversely with their size. The usual explanation for this is that small +2 cations polarize oxygen ions and destabilize their bonds with other cations. See KL Geisinger, GV Gibbs, A Navrotsky, A molecular orbital study of bond length and angle variations in framework silicates. *Phys Chem Minerals* 11: 266-285 (1985); and A Navrotsky, KL Geisinger, P McMillan, GV Gibbs, The tetrahedral framework in glasses and melts-inferences from molecular orbital calculations and physical properties. *Phys Chem Minerals*

11:284-298 (1985). The preferred +2 cations in the invention are CaO, MgO and SrO, in order of maximum concentration. The Ca^{2+} ion is better at stabilizing aluminum in 4-fold coordination than the Mg^{2+} ion, but not as effective as the Sr^{2+} ion. In the glasses of the present invention, Sr^{2+} will be completely consumed in charge-balancing interactions, followed by Ca^{2+} up to the limit that virtually all Al^{3+} ions are stabilized in 4-fold coordination by Ca^{2+} or Sr^{2+}. If Al^{3+} ions remain that still require charge-balance, Mg^{2+} ions will be used for this purpose until the remaining Al^{3+} ions are stabilized in 4-fold coordination.

The alkaline earth ions that are not used to stabilize aluminum in 4-fold coordination will tend to share oxygen ions with adjacent silicon ions. In this role, the alkaline earths are termed network modifying cations, because they break up the tetrahedral network of Si-O-Si and Si-O-Al bonds. Given the compositional constraints outlined below, the only alkaline earth ions that can be available as network modifying cations are Ca^{2+} and Mg^{2+}. In breaking up the network structure of the glass, the modifying cations contribute to reduced viscosity at elevated temperature, thereby facilitating the basic melting process. They also reduce the solubility of gases in the glass, thereby reducing the possibility of bubble nucleation and growth at high temperature. Further, they attack silica particles in the batch materials, causing them to be rapidly incorporated into a homogeneous melt. Finally, and most important for the present invention, they can reduce the stability of crystalline silica (e.g., cristobalite), stabilizing the liquid and thereby increasing the viscosity at which a crystal first appears on cooling. This is one of the key reasons why the $\Sigma[RO]/[Al_2O_3]$ ratio must be ≥ 1.

To understand this last role, i.e., the role of reducing the stability of crystalline silica, it is useful to consider the liquidus phase diagram of the $CaO\text{-}Al_2O_3\text{-}SiO_2$ system as depicted in Figure 1 (data used to prepare this figure are from EM Levin, CR Robbins, HF McMurdie, Phase Diagrams for Ceramists. The American Ceramic Society, Inc., Columbus, OH (1964), p. 219, converted to mole percent). The curves running through the middle of the diagram denote boundaries in composition space across which the crystal in equilibrium with a liquid changes its identity. At the top of the figure is cristobalite, a crystalline polymorph of SiO_2. To the lower right is mullite, approximately $3Al_2O_3 \cdot 2SiO_2$, an aluminosilicate containing aluminum in 4-, 5- and

6-fold coordination. In the lower middle of the diagram is the calcium aluminosilicate anorthite, $CaAl_2Si_2O_8$, in which the CaO/Al_2O_3 ratio is 1.0 and all Al^{3+} ions are 4-fold coordinated by oxygen. The phase in the lower left is wollastonite, $Ca_2Si_2O_6$, in which all Si^{4+} ions are 4-fold coordinated by oxygen, all Ca^{2+} ions are 6-fold coordinated by oxygen, and at least some of the oxygen ions are shared between Ca^{2+} and Si^{4+} ions. The vertical line running through the middle of the triangle denotes compositions for which the CaO/Al_2O_3 ratio is exactly 1.0. In each of these regions, the crystal in question is in equilibrium with a molten glass, and the region of equilibrium between liquid and a particular crystal is referred to as the liquidus phase field of the crystal.

Where two liquidus phase fields intersect, the curve indicating the intersection is called a cotectic, and where three phase fields intersect, the point at which the fields converge is referred to as a eutectic. Eutectics are locations where three crystalline phases simultaneously coexist with a liquid. They are, by definition, local minima in the melting temperatures of the particular crystalline assemblage, and therefore are the compositions for which the liquid is most stable relative to any one or combination of the three crystalline phases. Two eutectics are seen in Figure 1. The first, between cristobalite, anorthite and mullite (right-hand side) is a single melt down to 1345°C, at which point the three crystalline phases simultaneously come into equilibrium with the liquid. The second, between wollastonite, anorthite and cristobalite, is a single melt down to 1170°C, at which point those three phases simultaneously come into equilibrium with the liquid.

Were a crystalline assemblage of wollastonite, cristobalite and anorthite heated up from room temperature, the first appearance of a liquid would be at 1170°C, and the composition of the liquid would be equivalent to that of the corresponding eutectic composition. Likewise, were a crystalline assemblage of anorthite, mullite and cristobalite heated up from room temperature, the first appearance of a liquid would be at 1345°C and the composition of the liquid would be that of the corresponding eutectic between these phases. Between these two eutectics, temperatures increase monotonically to the line denoting $CaO/Al_2O_3 = 1.0$. This line denotes a thermal maximum in $RO\text{-}Al_2O_3\text{-}SiO_2$ systems, for R = Ca, Sr and Ba. In other words, $(Ca,Sr,Ba)O\text{-}Al_2O_3\text{-}SiO_2$ compositions to the Al_2O_3-rich side of the $(Ca,Sr,Ba)O/Al_2O_3=1$ line will melt at the [alkaline earth aluminosilicate]-mullite-

cristobalite eutectic composition, and are thermodynamically hindered from melting at the [alkaline earth silicate]-[alkaline earth aluminosilicate]-cristobalite side of the phase diagram.

Figure 2 shows the liquidus phase diagram of the MgO-Al_2O_3-SiO_2 system (data used to prepare this figure are from EM Levin, CR Robbins, HF McMurdie, Phase Diagrams for Ceramists. The American Ceramic Society, Inc., Columbus, OH (1964), p. 246, converted to mole percent). This system is unique among RO-Al_2O_3-SiO_2 systems in that the magnesium aluminosilicate (cordierite)-mullite-cristobalite eutectic composition has an $\Sigma[RO]/[Al_2O_3]$ ratio slightly greater than 1. Unlike the other RO-Al_2O_3-SiO_2 systems, initial melting of high-silica compositions in the magnesium-based system will thus tend to occur at eutectics with $\Sigma[RO]/[Al_2O_3] > 1.00$. Another point of considerable importance is that the eutectics in question are at much lower silica concentrations than any of the other RO-Al_2O_3-SiO_2 systems. Therefore, the lowest liquidus temperatures will be found at comparatively low silica concentrations in the MgO-Al_2O_3-SiO_2 system compared to the other RO-Al_2O_3-SiO_2 systems.

For the purposes of this invention, the most important consequences of the compositions of early-stage melts pertain to gas solubilities and the appearance of gaseous inclusions in the glass. The solubility of gases is comparatively high in aluminum-rich glasses and falls steeply as the $\Sigma[RO]/[Al_2O_3]$ ratio increases beyond 1.00. Furthermore, silica is the last component to dissolve during melting, and as it does so the solubility of gas decreases considerably. In RO-rich systems, silica dissolution occurs at a comparatively low temperature, thus further inhibiting initial gas solubility. The net impact of this is that RO-rich glasses have low initial gas solubility, and the solubility actually increases as melting proceeds, whereas Al_2O_3-rich glasses have very high initial solubility, but it decreases as melting proceeds. As solubility decreases, gas is forced out of the glass and into bubbles. The surfaces of partially-reacted silica particles serve as effective nucleation sites for these bubbles, and help keep them in the body of the glass.

Another key component of the invention is boric oxide, B_2O_3. It does not participate significantly in any of the binary or ternary aluminosilicate crystals nor in SiO_2, and as a consequence its main impact is to decrease liquidus temperature through

simple dilution. The main result is that for a given point on the liquidus surface of, for example, the $CaO-Al_2O_3-SiO_2$ system, the liquidus temperatures will decrease with addition of B_2O_3. It is found empirically in high silica liquids that the impact of B_2O_3 on liquidus temperatures is about twenty (20) degrees Centigrade per mol%. As an example, the temperature of the anorthite-cristobalite-mullite eutectic (on the Al_2O_3-rich side of Figure 1) decreases from 1345°C to about 1145°C when it is diluted by 10 mol% B_2O_3. The impact of dilution on liquidus temperatures is commonly referred to as freezing point depression.

A surprising result of composition investigations in AMLCD-type glass compositions is that the substitution of 1-3 mol% MgO for CaO in the $CaO-Al_2O_3-SiO_2$ system causes an abrupt shift in the position of the anothite-mullite-cristobalite liquidus to approximately the same position as the cordierite-mullite-cristobalite liquidus in the $MgO-Al_2O_3-SiO_2$ system. As a consequence, the addition of MgO not only forces all initial melting to the RO-rich side of the phase diagram, but also produces local minima in liquidus temperatures below those that might be expected from either the MgO- or CaO-based systems alone. The former follows from the discussion above concerning the $MgO-Al_2O_3-SiO_2$ system. The latter arises because the addition of a suitably small amount of any oxide will initially reduce liquidus temperatures via freezing point depression. Therefore, while intuitively one would anticipate an increase in liquidus temperatures because of the high temperatures in the ternary systems, i.e., systems having only MgO or CaO, one in fact obtains a decrease from about 1-3 mol%, followed by increasing liquidus temperatures thereafter. Since viscosity is not significantly impacted by the substitution of MgO for CaO, the net result of the decreasing liquidus temperature is an increase in liquidus viscosity. High liquidus viscosities are a prerequisite for precision sheet downdraw processes used to convert molten glass into sheet suitable for AMLCD applications.

Prior to the present invention, it was believed that MgO concentrations equal to or greater than 1 mole percent raised liquidus temperatures (lowered liquidus viscosities), thereby compromising high viscosity forming processes, such as, downdraw processes, e.g., fusion processes. However, as discussed above and illustrated by the examples presented below, it has been found that higher levels of

MgO can be used, provided that simultaneously, the $\Sigma[RO]/[Al_2O_3]$ ratio and SiO_2 concentration are carefully controlled as described above.

Thus, in sum, the foregoing considerations show that of the alkaline earth oxides, MgO is particularly important with regard to melting and fining. In addition, relative to the other alkaline earth oxides, the presence of MgO results in lower density and CTE, and a higher chemical durability, strain point, and modulus.

In terms of concentrations, MgO should be greater than or equal to 1.0 mole percent in order to achieve the various benefits associated with MgO described above. At concentrations greater than 3.0 mole percent, even with control of the $\Sigma[RO]/[Al_2O_3]$ ratio and the SiO_2 concentration, the liquidus temperature rises and liquidus viscosity falls such that forming the glass using a high viscosity forming process (e.g., a fusion process) is compromised. Preferably, the MgO concentration is between 1.2 and 2.8 mole percent, more preferably between 1.4 and 2.6 mole percent, and most preferably, between 1.6 and 2.4 mole percent.

Of the alkaline earth oxides, the CaO concentration in the glasses of the invention is the largest. CaO is essential to producing low liquidus temperatures (high liquidus viscosities), high strain points and moduli, and CTE's in the most desired ranges for flat panel applications, specifically, AMLCD applications. It also contributes favorably to chemical durability, and compared to other alkaline earth oxides it is relatively inexpensive as a batch material. Accordingly, the CaO concentration needs to be greater than or equal to 6.0 mole percent. However, at high concentrations, CaO increases density and CTE. Accordingly, the CaO concentration of the glasses of the invention is less than or equal to 11.5 mole percent. Preferably, the CaO concentration is between 6.5 and 10.5 mole percent.

The remaining alkaline earth oxides -- SrO and BaO -- can both contribute to low liquidus temperatures (high liquidus viscosities) and thus the glasses of the invention will typically contain at least one of these oxides. However, both oxides increase CTE and density and lower modulus and strain point compared to MgO and CaO. Between SrO and BaO, BaO generally has more adverse effects on glass properties than SrO. Accordingly, the BaO concentration in the glasses of the invention is less than or equal to 0.1 mole percent (preferably, less than 0.05 mole percent), while the SrO concentration is allowed to be greater, i.e., less than or equal to

2.0 mole percent, preferably, less than or equal to 1.0 mole percent. Typically, the sum of the SrO and BaO concentrations will be greater than or equal to 0.4 mole percent, primarily to provide a sufficiently high liquidus viscosity so that the glass can be formed by a downdraw process.

In addition to the above components, the glasses of the invention can include various other oxides to adjust various physical, melting, fining, and forming attributes of the glasses. Examples of such other oxides include, but are not limited to, TiO_2, MnO, ZnO, Nb_2O_5, MoO_3, Ta_2O_5, WO_3, Y_2O_3, La_2O_3, and CeO_2. The amount of each of these oxides should be less than or equal to 2.0 mole percent, and their total combined concentration should be less than or equal to 5.0 mole percent. The glasses of the invention will also include various contaminants associated with batch materials and/or introduced into the glass by the melting, fining, and/or forming equipment used to produce the glass, such as, Fe_2O_3 and ZrO_2. The glasses can also contain SnO_2 either as a result of Joule melting using tin-oxide electrodes and/or through the batching of tin containing materials, e.g., SnO_2, SnO, $SnCO_3$, SnC_2O_4, etc.

The glasses of the invention will also normally contain some alkali as contaminants. However, for AMLCD applications, the alkali levels need to be kept below 0.1 mole percent to avoid having a negative impact on thin film transistor (TFT) performance through diffusion of alkali ions from the glass into the silicon of the TFT. As used herein, an "alkali-free glass" is a glass having a total alkali concentration which is less than or equal to 0.1 mole percent, where the total alkali concentration is the sum of the Na_2O, K_2O, and Li_2O concentrations. Preferably, the total alkali concentration is less than or equal to 0.07 mole percent.

As discussed above, in accordance with the invention, it has been found that having an $\Sigma[RO]/[Al_2O_3]$ ratio greater than or equal to 1.00 improves fining, i.e., the removal of gaseous inclusions from the melted batch materials. This improvement allows for the use of more environmentally friendly fining packages. For example, on an oxide basis, the glasses of the invention, can have one or more of the following compositional characteristics:

(i) an As_2O_3 concentration of at most 0.05 mole percent;

(ii) an Sb_2O_3 concentration of at most 0.05 mole percent;

(iii) a SnO_2 concentration of at least 0.01 mole percent.

As is well-known, As_2O_3 is the most effective high temperature fining agent for AMLCD glasses, and in some embodiments of the present invention, As_2O_3 is used for fining because of its superior fining properties. However, As_2O_3 is poisonous and thus requires special handling during the glass manufacturing process. Accordingly, in certain preferred embodiments, fining is performed without the use of substantial amounts of As_2O_3, i.e., the finished glass has at most 0.05 mole percent As_2O_3. Most preferably, no As_2O_3 is purposely used in the fining of the glass. In such cases, the finished glass will typically have at most 0.005 mole percent As_2O_3 as a result of contaminants present in the batch materials and/or the equipment used to melt the batch materials.

Although not as toxic as As_2O_3, Sb_2O_3 is also poisonous and requires special handling. In addition, Sb_2O_3 raises the density, raises the CTE, and lowers the strain point in comparison to glasses which use As_2O_3 or SnO_2 as a fining agent. Accordingly, in certain preferred embodiments, fining is performed without the use of substantial amounts of Sb_2O_3, i.e., the finished glass has at most 0.05 mole percent Sb_2O_3. Most preferably, no Sb_2O_3 is purposely used in the fining of the glass. In such cases, the finished glass will typically have at most 0.005 mole percent Sb_2O_3 as a result of contaminants present in the batch materials and/or the equipment used to melt the batch materials.

Compared to As_2O_3 and Sb_2O_3 fining, tin fining (i.e., SnO_2 fining) is less effective, but SnO_2 is a ubiquitous material which has no known hazardous properties. Also, for many years, SnO_2 has been a component of AMLCD glasses through the use of tin oxide electrodes in the Joule melting of the batch materials for such glasses (e.g., the melting of Corning Incorporated Code 7059, 1737, and EAGLE 2000 glasses). The presence of SnO_2 in AMLCD glasses has not resulted in any known adverse effects in the use of these glasses in the manufacture of liquid crystal displays. SnO_2, however, can form crystalline defects in AMLCD glasses when used at high concentrations. Accordingly, the concentration of SnO_2 in the finished glass is preferably less than or equal to 0.15 mole percent.

Tin fining can be used alone or in combination with other fining techniques if desired. For example, tin fining can be combined with halide fining, e.g., bromine fining. Other possible combinations include, but are not limited to, tin fining plus

sulfate, sulfide, cerium oxide, mechanical bubbling, and/or vacuum fining. Also, these other fining techniques can be used by themselves (or in combinations) without the use of tin fining. In all of these cases, maintaining an $\Sigma[RO]/[Al_2O_3]$ ratio and MgO concentration in the ranges discussed above makes the fining process easier to perform and more effective.

The glasses of the invention can be manufactured using various techniques known in the art. Preferably, the glasses are made using a downdraw process and, most preferably, by a fusion downdraw process. Compared to other forming processes, such as the float process, the fusion process is preferred for several reasons. First, glass substrates made from the fusion process do not require polishing. Current glass substrate polishing is capable of producing glass substrates having an average surface roughness greater than about 0.5 nm (Ra), as measured by atomic force microscopy. Glass substrates produced according to the present invention and using the fusion process have an average surface roughness as measured by atomic force microscopy of less than 0.5 nm. The substrates also have an average internal stress as measured by optical retardation which is less than or equal to 150 psi.

The invention is further illustrated by the following examples, which are meant to be illustrative, and not in any way limiting, to the claimed invention.

In particular, Table 1 lists examples of the glasses of the invention and comparative glasses in terms of mole percents which are either calculated on an oxide basis from the glass batches in the case of the crucible melts or determined from measurements on the finished glass for the compositions prepared using the continuous melter (see below). Table 1 also lists various physical properties for these glasses, the units for these properties being as follows:

Density	grams/centimeter^3
CTE	x 10^{-7}/°C (0-300°C)
Strain Point	°C
Young's Modulus	x 10^{+6} psi
Melting Temp.	°C
Liquidus Temp.	°C
Liquidus Viscosity	poises

Inasmuch as the sum of the individual constituents totals or very closely approximates 100, for all practical purposes the reported values may be deemed to represent mole percent. The actual batch ingredients may comprise any materials, either oxides, or other compounds, which, when melted together with the other batch components, will be converted into the desired oxide in the proper proportions. For example, $SrCO_3$ and $CaCO_3$ can provide the source of SrO and CaO, respectively.

The specific batch ingredients used to prepare the glasses of Table 1 were fine sand, alumina, boric acid, magnesium oxide, limestone, strontium carbonate or strontium nitrate, and tin oxide.

The glasses of Examples 1-6, 9-11, 29-31, 33-34, 36-42, and 46-52 were prepared by melting 3,000 gram batches of each glass composition at a temperature and time to result in a relatively homogeneous glass composition, e.g., at a temperature of about 1600°C for a period of about 16 hours in platinum crucibles. In particular, the batch materials were ball-milled for one hour using ceramic media in a ceramic mill. The batch was transferred to an 1800 cc platinum crucible and loaded into a furnace at 1600°C. After 16 hours, the crucible was removed from the furnace and the glass was poured onto a cold steel plate. When viscous enough to handle, the glass was transferred to an annealing oven at 725°C, held for one hour at this temperature, then cooled at 0.5°C/minute to room temperature.

In Examples 7-8, 12-28, 32, 35, and 43-45, the melting was done in a laboratory scale, continuous, Joule-heated melter. Batches of the raw materials massing 45.4 kg were weighed into a mechanical mixer and combined together for five minutes. An amount of water corresponding to about 0.25 kg was added to the mixture during the last 60 seconds of mixing to reduce dust generation. The mixture was loaded using a screw feeder into a ceramic-lined furnace with tin oxide electrodes and opposing burners firing over the melt surface. The power supplied by the electrodes was controlled by keeping the glass at a near-constant resistivity, corresponding to temperatures between 1590°C and 1610°C. The glass moved from the melter into a platinum-based conditioning system consisting of a high-temperature finer followed by a stir chamber. The finer and stir chamber temperatures were kept constant throughout the experiment, whereas the melt temperature of the ceramic-lined melter was allowed to vary with composition. The glass drained out of the stir chamber through a heated

orifice and was rolled into a ribbon approximately 5 mm thick and 30 mm wide. The glass from the ribbon was analyzed periodically for defects, which were identified, counted, and converted to defects per pound. Compositions were obtained from the ribbon via standard chemical methods, and physical properties were obtained as described below.

The glass properties set forth in Table 1 were determined in accordance with techniques conventional in the glass art. Thus, the linear coefficient of thermal expansion (CTE) over the temperature range 0-300°C is expressed in terms of x 10^{-7}/°C and the strain point is expressed in terms of °C. These were determined from fiber elongation techniques (ASTM references E228-85 and C336, respectively). The density in terms of grams/cm^3 was measured via the Archimedes method (ASTM C693). The melting temperature in terms of °C (defined as the temperature at which the glass melt demonstrates a viscosity of 200 poises) was calculated employing a Fulcher equation fit to high temperature viscosity data measured via rotating cylinders viscometry (ASTM C965-81). The liquidus temperature of the glass in terms of °C was measured using the standard gradient boat liquidus method of ASTM C829-81. This involves placing crushed glass particles in a platinum boat, placing the boat in a furnace having a region of gradient temperatures, heating the boat in an appropriate temperature region for 24 hours, and determining by means of microscopic examination the highest temperature at which crystals appear in the interior of the glass. The liquidus viscosity in poises was determined from the liquidus temperature and the coefficients of the Fulcher equation. Young's modulus values in terms of Mpsi were determined using a resonant ultrasonic spectroscopy technique of the general type set forth in ASTM E1875-00e1.

As can be seen in Table 1, Examples 1-43 have densities, CTE's, strain points, and Young's modulus values that make the glasses suitable for use in display applications, such as AMLCD applications. Although not shown in Table 1, the glasses also have chemical durabilities suitable for these applications. In particular, Examples 12, 13, 23 and 28 were each found to have 110BHF values of between 1.25 and 1.35 milligrams/cm^2 and HCl durabilities of between 0.5 and 0.8 milligrams/cm^2. The glasses of Examples 1-43 can also be formed using downdraw techniques, such as the fusion technique. Thus, they have liquidus temperatures less than or equal to 1170°C

and liquidus viscosities equal to or greater than 100,000, and in most cases, equal to or greater than 150,000.

Glasses having the compositions and properties shown in Examples 23 and 28 are currently regarded as representing the most preferred embodiments of the invention, that is, as providing the best combination of properties for the purposes of the invention at this time.

Examples 44 and 45 illustrate glasses which have liquidus viscosities less than 100,000 poises. Example 44 was found to produce mullite upon crystallization, which is an undesirable liquidus phase for downdraw processes. The presence of this phase can be eliminated by a small increase in the $\Sigma[RO]/[Al_2O_3]$ ratio. More generally, in the compositional space of the present invention, localized regions exist where the liquidus phase is mullite. These regions can be easily recognized by persons skilled in the art from the present disclosure and avoided by small changes in the $\Sigma[RO]/[Al_2O_3]$ ratio.

Example 45 has a MgO concentration close to the upper limit of 3.0 mole percent. As noted above, as MgO increases, the liquidus temperatures initially go down but then increase. Example 45 illustrates this later effect.

Examples 46-48 have $\Sigma[RO]/[Al_2O_3]$ ratios of less than 1.00 and thus have either a low liquidus viscosity (Example 46) or high melting temperatures (Examples 47 and 48). Examples 48-52 have MgO concentrations less than 1.0 mole percent and thus have high or marginal melting temperatures (Examples 48-50) or high CTE's (Examples 51 and 52).

Figure 3 illustrates the dramatic improvement in defect levels that can be achieved by switching the $\Sigma[RO]/[Al_2O_3]$ ratio of a glass from below 1.00 to above 1.00. This graph shows the results of an experimental study done over a 30 day period in which the $\Sigma[RO]/[Al_2O_3]$ ratio was adjusted by increasing CaO and/or MgO at the expense of Al_2O_3 and/or SiO_2. The triangular data points show the $\Sigma[RO]/[Al_2O_3]$ ratios on the various days of the experiment, and the solid circles show the number of inclusions per pound. As can be seen, as soon as the $\Sigma[RO]/[Al_2O_3]$ ratio broke through the 1.00 level, the inclusion level dropped by essentially two orders of magnitude and remained at low levels even with changes in CaO and/or MgO.

Throughout the experiment, the MgO concentration was greater than 1.0 mole percent and the SiO_2 concentration was less than 71 mole percent.

The glass of Example 23 was produced using a downdraw process, specifically, a full-scale fusion process, and was found to produce a population of 50 sequential glass sheets which had an average inclusion level of less than 0.05 gaseous inclusions/cubic centimeter, each sheet in the population having a volume of at least 500 cubic centimeters.

Although the invention has been described in detail for the purpose of illustration, it is understood that such detail is solely for that purpose and variations can be made therein by those skilled in the art without departing from the spirit and scope of the invention which is defined by the following claims.

TABLE 1

Composition (mol%)	1	2	3	4	5	6
SiO_2	68.80	68.64	68.95	68.95	68.98	68.98
Al_2O_3	10.55	10.60	10.49	10.49	10.45	10.45
B_2O_3	9.94	9.99	9.90	9.90	9.90	9.90
MgO	2.01	2.02	1.00	2.00	1.00	2.00
CaO	8.13	8.18	9.09	8.09	9.10	8.10
SrO	0.50	0.50	0.50	0.50	0.50	0.50
SnO_2	0.07	0.07	0.07	0.07	0.07	0.07
$\Sigma[RO]/[Al_2O_3]$	1.01	1.01	1.01	1.01	1.01	1.01
Properties						
Density	2.378	2.378	2.385	2.381	--	--
CTE	31.3	31.5	32.0	30.5	--	--
Strain Point	677	670	691	688	--	--
Young's Modulus	10.6	10.6	--	--	--	--
Melting Temp.	1629	1641	1649	1645	1640	--
Liquidus Temp.	1165	1150	1165	1140	1145	1150
Liquidus Viscosity	158000	235000	214000	370000	262000	--

Composition (mol%)	7	8	9	10	11	12
SiO_2	69.41	68.91	68.44	68.59	68.75	69.25
Al_2O_3	10.19	10.40	10.60	10.55	10.49	10.21
B_2O_3	9.96	9.94	9.99	9.94	9.90	9.96
MgO	1.87	1.98	1.21	1.21	1.20	2.04
CaO	7.98	7.45	9.19	9.14	9.09	7.96
SrO	0.52	1.25	0.50	0.50	0.50	0.51
SnO_2	0.07	0.07	0.07	0.07	0.07	0.07
$\Sigma[RO]/[Al_2O_3]$	1.02	1.03	1.03	1.03	1.03	1.03
Properties						
Density	2.365	2.390	2.384	2.383	2.386	2.366
CTE	30.7	31.8	32.9	32.0	31.1	31.4
Strain Point	664	665	680	674	689	664
Young's Modulus	--	--	10.5	10.6	--	--
Melting Temp.	1641	1631	1628	1632	1646	1640
Liquidus Temp.	1145	1120	1135	1140	1150	1150
Liquidus Viscosity	263000	371000	294000	279000	273000	225000

TABLE 1 (continued)

Composition (mol%)	13	14	15	16	17	18
SiO_2	68.84	68.18	69.16	67.59	67.65	69.32
Al_2O_3	10.42	10.69	10.28	11.06	11.06	10.17
B_2O_3	9.94	10.04	9.88	9.84	9.74	9.86
MgO	1.98	1.49	1.80	2.25	2.26	2.33
CaO	7.42	8.84	8.30	8.65	8.67	7.74
SrO	1.33	0.69	0.51	0.54	0.55	0.51
SnO_2	0.07	0.07	0.07	0.07	0.07	0.07
$\Sigma[RO]/[Al_2O_3]$	1.03	1.03	1.03	1.03	1.04	1.04
Properties						
Density	2.391	2.379	2.368	2.384	2.385	2.365
CTE	32.3	32.5	31.1	31.5	31.6	30.4
Strain Point	664	663	665	665	665	666
Young's Modulus	--	--	--	--	--	--
Melting Temp.	1622	1621	1632	1612	1606	1635
Liquidus Temp.	1105	1125	1125	1140	1135	1150
Liquidus Viscosity	530000	305000	376000	195000	224000	217000

Composition (mol%)	19	20	21	22	23	24
SiO_2	69.06	68.64	68.01	68.46	69.28	69.08
Al_2O_3	10.23	10.46	10.66	10.49	10.18	10.23
B_2O_3	9.97	9.90	10.11	9.99	9.79	9.88
MgO	1.87	1.82	1.84	1.84	1.85	1.88
CaO	8.31	8.62	8.71	8.66	8.34	8.37
SrO	0.49	0.49	0.60	0.49	0.49	0.49
SnO_2	0.07	0.07	0.07	0.07	0.07	0.07
$\Sigma[RO]/[Al_2O_3]$	1.04	1.04	1.05	1.05	1.05	1.05
Properties						
Density	2.369	2.374	2.378	2.375	2.369	2.371
CTE	31.2	31.5	32.3	31.5	31.1	31.2
Strain Point	665	664	667	666	666	665
Young's Modulus	--	--	--	--	--	--
Melting Temp.	1637	1624	1616	1619	1644	1621
Liquidus Temp.	1130	1115	1130	1120	1145	1135
Liquidus Viscosity	360000	408000	275000	363000	233000	243000

TABLE 1 (continued)

Composition (mol%)	25	26	27	28	29	30
SiO_2	68.88	69.11	68.52	67.80	68.29	68.45
Al_2O_3	10.37	10.17	10.43	10.83	10.55	10.49
B_2O_3	9.79	9.96	10.01	9.90	9.95	9.90
MgO	1.96	2.22	1.21	2.18	2.51	2.50
CaO	8.45	7.96	9.25	8.74	8.13	8.09
SrO	0.48	0.51	0.51	0.48	0.50	0.50
SnO_2	0.07	0.07	0.07	0.07	0.07	0.07
$\Sigma[RO]/[Al_2O_3]$	1.05	1.05	1.05	1.05	1.06	1.06
Properties						
Density	2.375	2.367	2.371	2.384	2.380	2.379
CTE	31.8	31.1	32.2	32.1	31.8	30.8
Strain Point	668	664	665	667	671	669
Young's Modulus	--	--	--	--	10.7	10.6
Melting Temp.	1630	1634	1627	1612	1633	1632
Liquidus Temp.	1120	1115	1115	1120	1150	1165
Liquidus Viscosity	408000	481000	448000	330000	219000	148000

Composition (mol%)	31	32	33	34	35	36
SiO_2	69.75	67.45	68.09	68.25	68.51	68.11
Al_2O_3	10.70	10.88	10.55	10.49	10.30	10.44
B_2O_3	8.16	10.02	9.94	9.90	10.03	9.85
MgO	1.28	2.04	1.71	1.70	1.65	2.98
CaO	9.58	9.00	9.14	9.09	8.93	8.05
SrO	0.46	0.54	0.50	0.50	0.51	0.50
SnO_2	0.07	0.07	0.07	0.07	0.07	0.07
$\Sigma[RO]/[Al_2O_3]$	1.06	1.06	1.08	1.08	1.08	1.10
Properties						
Density	2.405	2.384	2.388	2.386	2.373	2.382
CTE	32.9	32.7	31.4	32.6	32.6	31.0
Strain Point	684	661	673	674	664	668
Young's Modulus	--	--	10.6	10.6	--	10.7
Melting Temp.	--	1610	1619	1622	1640	1626
Liquidus Temp.	1155	1135	1155	1150	1130	1170
Liquidus Viscosity	--	200000	156000	177000	311000	122000

TABLE 1 (continued)

Composition (mol%)	37	38	39	40
SiO_2	67.95	68.73	68.73	68.65
Al_2O_3	10.49	10.10	10.10	10.09
B_2O_3	9.90	9.90	9.90	9.90
MgO	3.00	1.00	2.00	1.10
CaO	8.09	9.70	8.70	9.69
SrO	0.50	0.50	0.50	0.50
SnO_2	0.07	0.07	0.07	0.07
$\Sigma[RO]/[Al_2O_3]$	1.10	1.11	1.11	1.12
Properties				
Density	2.385	--	--	2.390
CTE	30.7	--	--	33.3
Strain Point	671	--	--	685
Young's Modulus	10.7	--	--	--
Melting Temp.	1616	1637	1631	1644
Liquidus Temp.	1155	1150	1150	1145
Liquidus Viscosity	155000	201000	177000	269000

Composition (mol%)	41	42	43
SiO_2	67.75	67.91	68.53
Al_2O_3	10.49	10.44	10.04
B_2O_3	9.90	9.84	10.04
MgO	2.20	2.19	1.94
CaO	9.09	9.05	8.90
SrO	0.50	0.50	0.48
SnO_2	0.07	0.07	0.07
$\Sigma[RO]/[Al_2O_3]$	1.12	1.12	1.13
Properties			
Density	2.390	2.393	2.373
CTE	33.3	33.1	32.6
Strain Point	670	668	661
Young's Modulus	10.7	10.7	□
Melting Temp.	1611	1615	1620
Liquidus Temp.	1145	1140	1115
Liquidus Viscosity	173000	204000	362000

TABLE 1 (continued)

Composition (mol%)	44	45	46	47	48
SiO_2	68.79	68.09	69.25	69.25	69.25
Al_2O_3	10.41	10.86	10.79	10.79	10.79
B_2O_3	9.92	9.80	9.90	9.90	9.90
MgO	1.97	2.88	2.00	1.00	0.00
CaO	7.81	7.77	7.49	8.49	9.49
SrO	1.03	0.53	0.50	0.50	0.50
SnO_2	0.07	0.07	0.07	0.07	0.07
$\Sigma[RO]/[Al_2O_3]$	1.04	1.03	0.93	0.93	0.93
Properties					
Density	2.385	2.380	--	2.364	2.385
CTE	31.9	30.4	--	29.6	31.3
Strain Point	666	669	--	--	--
Young's Modulus	--	--	--	--	--
Melting Temp.	1622	1615	1645	1688	1671
Liquidus Temp.	1210	1200	1220	1200	1160
Liquidus Viscosity	52000	59000	58000	137000	294000

Composition (mol%)	49	50	51	52
SiO_2	68.98	68.73	68.45	68.45
Al_2O_3	10.45	10.10	10.19	10.09
B_2O_3	9.90	9.90	9.90	9.90
MgO	0.00	0.00	0.30	0.30
CaO	10.10	10.70	10.59	10.69
SrO	0.50	0.50	0.50	0.50
SnO_2	0.07	0.07	0.07	0.07
$\Sigma[RO]/[Al_2O_3]$	1.01	1.11	1.12	1.14
Properties				
Density	2.394	2.375	2.397	2.395
CTE	33.4	33.4	35.6	34.7
Strain Point	--	--	686	685
Young's Modulus	--	--	--	--
Melting Temp.	1674	1650	1637	1638
Liquidus Temp.	1160	1160	1170	1160
Liquidus Viscosity	246000	173000	143000	172000

What is claimed is:

1. An alkali-free glass comprising in mole percent on an oxide basis:

SiO_2:	64.0-71.0
Al_2O_3:	9.0-12.0
B_2O_3:	7.0-12.0
MgO:	1.0-3.0
CaO:	6.0-11.5
SrO:	0-2.0
BaO:	0-0.1

wherein:

(a) $1.00 \leq \Sigma[RO]/[Al_2O_3] \leq 1.25$,

where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO; and

(b) the glass has at least one of the following compositional characteristics:

(i) on an oxide basis, the glass comprises at most 0.05 mole percent Sb_2O_3;

(ii) on an oxide basis, the glass comprises at least 0.01 mole percent SnO_2.

2. The glass of Claim 1 wherein the glass has both compositional characteristics (i) and (ii).

3. The glass of Claim 1 wherein:

(a) the glass has compositional characteristic (i); and

(b) the glass has the further compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3.

4. The glass of Claim 1 wherein:

(a) the glass has compositional characteristic (ii); and

(b) the glass has the further compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3.

5. The glass of Claim 1 wherein:

(a) the glass has both compositional characteristics (i) and (ii); and

(b) the glass has the further compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3.

6. The glass of Claim 1 wherein on an oxide basis, SrO is at most 1.0 mole percent.

7. The glass of Claim 1 wherein the glass has a density that is less than or equal to 2.41 grams/cm^3.

8. The glass of Claim 1 wherein the glass has one or more of the following properties:

(a) a liquidus viscosity that is greater than or equal to 100,000 poise;

(b) a strain point that is greater than or equal to 650°C;

(c) a linear coefficient of thermal expansion (CTE) over the temperature range 0-300 °C which satisfies the relationship:

$$28 \times 10^{-7}/°C \leq CTE \leq 34 \times 10^{-7}/°C.$$

9. An alkali-free glass comprising in mole percent on an oxide basis:

SiO_2:	64.0-71.0
Al_2O_3:	9.0-12.0
B_2O_3:	7.0-12.0
MgO:	1.0-3.0
CaO:	6.0-11.5
SrO:	0-1.0
BaO:	0-0.1

wherein:

$$\Sigma[RO]/[Al_2O_3] \geq 1.00,$$

where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO.

10. The glass of Claim 9 wherein:

$\Sigma[RO]/[Al_2O_3] \leq 1.25$.

11. The glass of Claim 9 wherein the glass has a density that is less than or equal to 2.41 grams/cm^3.

12. The glass of Claim 9 wherein the glass has one or more of the following properties:

(a) a liquidus viscosity that is greater than or equal to 100,000 poise;

(b) a strain point that is greater than or equal to 650°C;

(c) a linear coefficient of thermal expansion (CTE) over the temperature range 0-300 °C which satisfies the relationship:

$$28 \times 10^{-7}/°C \leq CTE \leq 34 \times 10^{-7}/°C.$$

13. The glass of Claim 9 wherein the glass has at least one of the following compositional characteristics:

(a) on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3;

(b) on an oxide basis, the glass comprises at most 0.05 mole percent Sb_2O_3;

(c) on an oxide basis, the glass comprises at least 0.01 mole percent SnO_2.

14. The glass of Claim 13 wherein the glass has compositional characteristics (a) and (b).

15. The glass of Claim 13 wherein the glass has compositional characteristics (a) and (c).

16. The glass of Claim 13 wherein the glass has compositional characteristics (b) and (c).

17. The glass of Claim 13 wherein the glass has compositional characteristics (a), (b), and (c).

18. A method for producing alkali-free glass sheets by a downdraw process comprising selecting, melting, and fining batch materials so that the glass making up the sheets comprises SiO_2, Al_2O_3, B_2O_3, MgO, and CaO, and, on an oxide basis, has:

(i) a $\Sigma[RO]/[Al_2O_3]$ ratio greater than or equal to 1.0, where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ is the sum of the mole percents of MgO, CaO, SrO, and BaO; and

(ii) a MgO content greater than or equal to 1.0 mole percent;

wherein:

(a) the fining is performed without the use of substantial amounts of either arsenic or antimony; and

(b) a population of 50 sequential glass sheets produced by the downdraw process from the melted and fined batch materials has an average gaseous inclusion level of less than 0.05 gaseous inclusions/cubic centimeter, where each sheet in the population has a volume of at least 500 cubic centimeters.

19. The method of Claim 18 wherein SnO_2 is used in the fining.

20. The method of Claim 18 wherein the glass making up the sheets is substantially free of BaO.

ABSTRACT OF THE DISCLOSURE

Glasses are disclosed which can be used to produce substrates for flat panel display devices, e.g., active matrix liquid crystal displays (AMLCDs). The glasses have MgO concentrations in the range from 1.0 mole percent to 3.0 mole percent and $\Sigma[RO]/[Al_2O_3]$ ratios greater than or equal to 1.00, where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO. These compositional characteristics have been found to improve the melting properties of batch materials used to produce the glass, which, in turn, allows the glasses to be fined (refined) with more environmentally friendly fining agents, e.g., tin as opposed to arsenic and/or antimony.

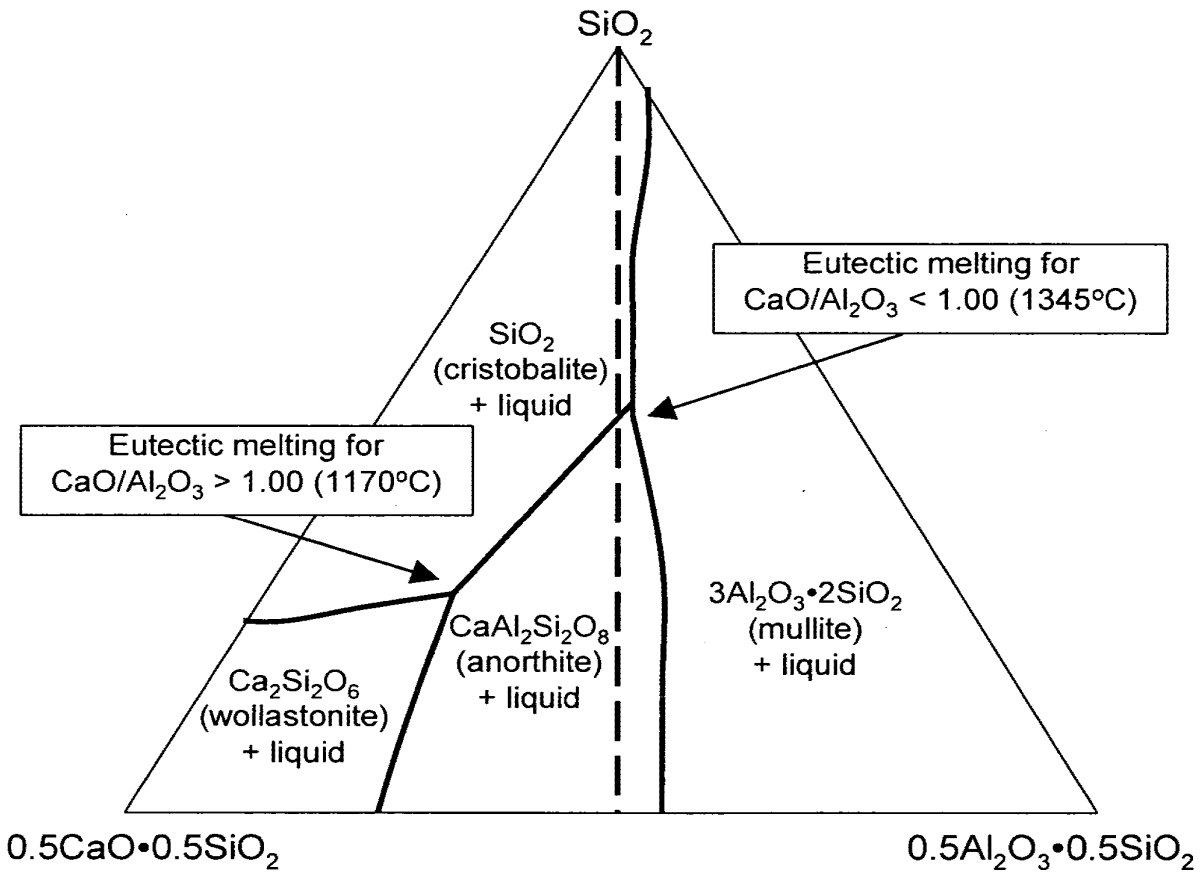

SiO2
Eutectic melting for
CaO/Al2O3 < 1.00 (1345°C)
SiO2
(cristobalite)
+ liquid
Eutectic melting for
CaO/Al2O3 > 1.00 (1170°C)
3Al2O3•2SiO2
(mullite)
+ liquid
CaAl2Si2O8
(anorthite)
+ liquid
Ca2Si2O6
(wollastonite)
+ liquid
0.5CaO•0.5SiO2
0.5Al2O3•0.5SiO2

FIG. 1

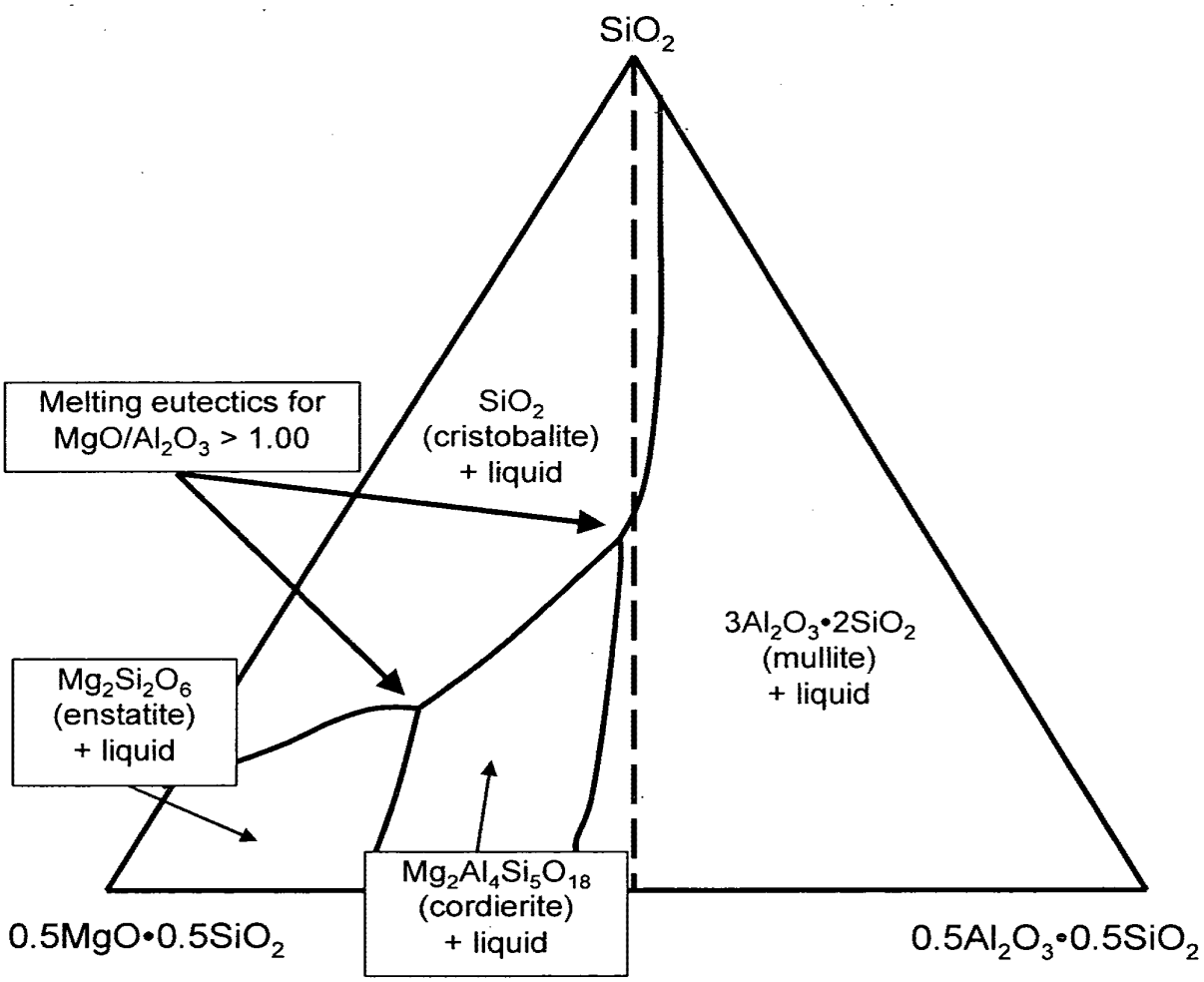

SiO_2
Melting eutectics for $MgO/Al_2O_3 > 1.00$
SiO_2 (cristobalite) + liquid
$3Al_2O_3 \cdot 2SiO_2$ (mullite) + liquid
$Mg_2Si_2O_6$ (enstatite) + liquid
$Mg_2Al_4Si_5O_{18}$ (cordierite) + liquid
$0.5MgO \cdot 0.5SiO_2$
$0.5Al_2O_3 \cdot 0.5SiO_2$

FIG. 2

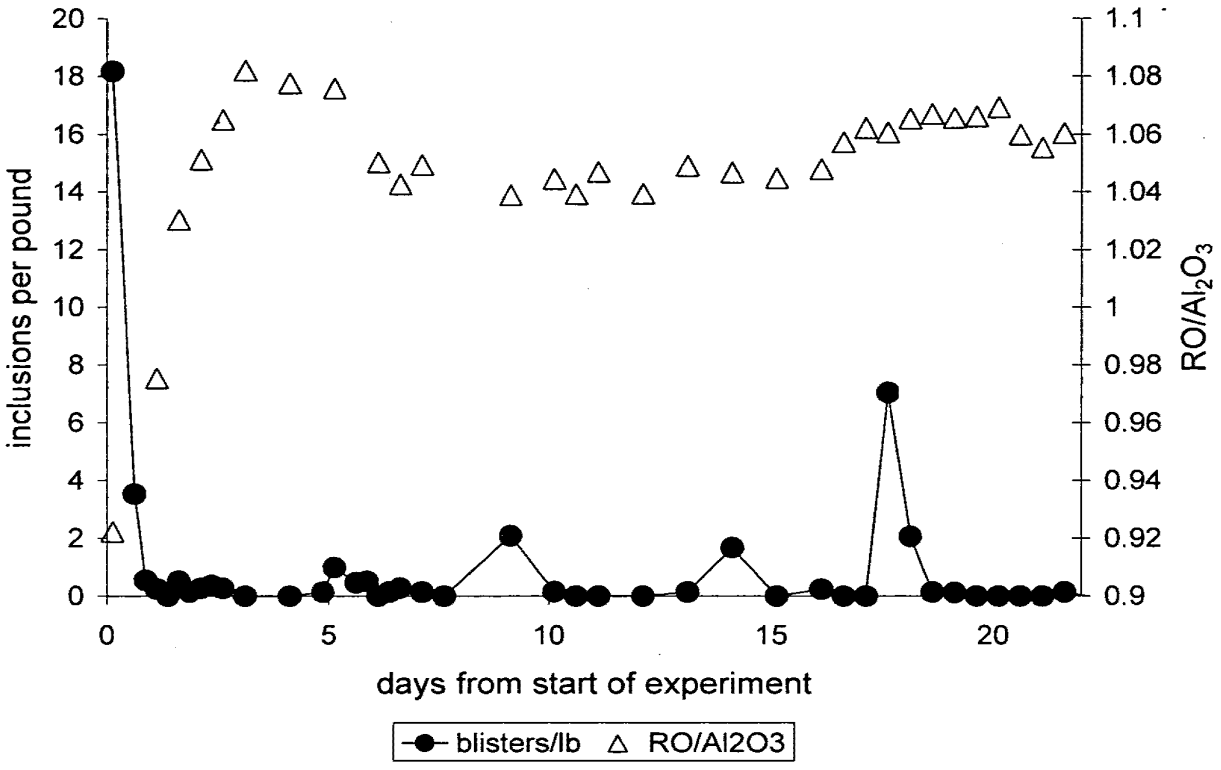

20
18
16
14
12
10
8
6
4
2
0
inclusions per pound
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
RO/Al2O3
0
5
10
15
20
days from start of experiment
blisters/lb
RO/Al2O3

FIG. 3

DECLARATION IN ORIGINAL APPLICATION U.S. Attorney Docket No.: **ADP-231 (SP05-073)**

As a below named inventor, I declare that:

My residence, Post Office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **FINING OF BOROALUMINO SILICATE GLASSES.**

The specification of which (check only one item below):

☒ is attached hereto

☐ was filed as United States Application Serial No. 60/694478 on June 28, 2005 and was amended on (if applicable)

☐ was filed as PCT international application number , on , and was amended under PCT Article 19 on (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate or 365(a) of any PCT international application which designated at least one country other than the Unites States, listed below and have also identified below any foreign application for patent or inventor's certificate, on the same subject matter, having a filing date before that of the application on which priority is claimed:

☐	**Country:**	**Application No.:**	**Filing Date:**
☒	**NONE**		

I hereby claim the benefit under Title 35 United States Code § 119(e) and § 120 of any United States application(s) or 365(c) of any PCT international application designating the United States listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35 United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37 Code of Federal Regulations, § 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

☒	**Provisional No.:** 60/694,478	**Filed:** 06-28-2005	**Status:** Pending
☐	**Application No.:**	**Filed:**	**Status:**
☐	**PCT Application No:**	**Filed:**	**Status:**
☐	**NONE**		

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Inventor: Adam J.G. Ellison

Resident Address: 453 Beartown Road, Painted Post, New York 14870
Post Office Address: same

Citizenship: UNITED STATES

DATE: 6/27/06

Adam J.G. Ellison

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	Adam J.G. Ellison	**COMBINED CERTIFICATE UNDER 37 C.F.R. § 3.73(b) and POWER OF ATTORNEY**
Serial No.:		
Filed:		
For:	FINING OF BOROALUMINO SILICATE GLASSES	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE UNDER 37 C.F.R. § 3.73(b)

CORNING INCORPORATED, a New York corporation, certifies that it is the assignee of the entire right, title and interest in the patent application identified above by virtue of an assignment from the inventor(s) of the patent application identified above. A true copy of the unrecorded Assignment is attached hereto.

The undersigned has reviewed the above referenced assignment of the patent application identified above and, to the best of the undersigned's knowledge and belief, title is in the assignee identified above.

The undersigned is empowered to sign this certificate on behalf of the assignee.

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

(U.S.) Attorney Docket No.: **ADP-231 (SP05-073)**

POWER OF ATTORNEY BY ASSIGNEE

CORNING INCORPORATED, the assignee of the full and exclusive right, title and interest in and to the accompanying application for United States Letters Patent entitled **FINING OF BOROALUMINO SILICATE GLASSES** and executed by Adam J.G. Ellison on 06-22-2006, respectively, appoints the practitioners associated with the Customer Number provided below (i.e., the practitioners associated with the Intellectual Property Department, Corning Incorporated) to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected therewith. Please direct all correspondence to **Thomas R. Beall** at the address associated with that Customer Number.

Customer Number: 22928

CORNING INCORPORATED

Date: June 28, 2006

By _____
Mark W. Lauroesch
Assistant Secretary

ASSIGNMENT

FOR VALUE RECEIVED, I, as a below named inventor, hereby sell, assign and transfer unto Corning Incorporated, a corporation organized and existing under the laws of the State of New York, having its principal place of business at Corning, New York, (hereinafter CORNING), as assignee, and unto its successors, assigns and legal representatives, the entire right, title and interest, for all countries, in and to certain inventions relating to a **FINING OF BOROALUMINO SILICATE GLASSES**, such inventions being generally described in an application for Letters Patent of the United States executed on

DATE June 22, 2006

and in any future patent applications claiming the benefit of the filing date of that application, and all the rights and privileges under any and all Letters Patents that may be granted therefore.

I request that any and all patents for said inventions be issued to CORNING, its successors, assigns and legal representatives, or to such nominees as CORNING may designate.

I agree that, when requested, I will, without charge to CORNING and at CORNING's expense, sign all papers, take all rightful oaths, and do all acts which may be necessary, desirable or convenient for securing and maintaining patents for said inventions in any and all countries and for vesting title thereto in CORNING, its successors, assigns and legal representatives or nominees.

I authorize and empower CORNING, its successors, assigns and legal representatives or nominees, to invoke and claim for any application for patent or other form of protection for said inventions filed by it or them, the benefit of the right of priority provided by the International Convention for the Protection of Industrial Property, as amended, or by any convention which may henceforth be substituted for said Convention or entered as a supplement to, and to invoke and claim such right of priority without further written or oral authorization.

I hereby consent that a copy of this assignment shall be deemed a full legal and formal equivalent of any assignment, consent to file or like document which may be required in any country for any purpose and more particularly in proof of the right of CORNING, or its successors, assigns and legal representatives or nominees to claim the aforesaid benefit of the right of priority provided by the International Convention for the Protection of Industrial Property, as amended, or by any convention which may henceforth be substituted for it or entered as a supplement to it.

I covenant with CORNING, its successors, assigns and legal representatives or nominees, that the rights and property herein conveyed are free and clear of any encumbrance, and that I have full right to convey the same as herein expressed.

Signed at Corning, NY, this

6/22/06
Date

Adam J.G. Ellison

State of New York)
: ss.
County of Steuben)

On the 22 day of June 2006, before me personally came **Adam J.G. Ellison** known to be the person described in and who executed the foregoing instrument, and acknowledged that they executed the same.

Betty L. Davis
Notary Public

Betty L. Davis
Notary Public, State of New York
Qualified in Steuben County No. 01DA6146735
My Commission Expires May 22, 2010

BEST AVAILABLE COPY

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

07/05/2006 HLE333 00000058 033325 11478493

01 FC:1011 300.00 DA
02 FC:1111 500.00 DA
03 FC:1311 200.00 DA

PTO-1556
(5/87)

*U.S. Government Printing Office: 2002 — 489-267/60033

PTO/SB/06 (12-04)
Approved for use through 7/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875 Effective December 8, 2004

Application or Docket Number 11/784,493

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	150.00		N/A	300.00
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	$250		N/A	$500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	$100		N/A	$200
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	* 0	X$ 25 =		OR	X$50 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	* 0	X100 =			X200 =	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			+180=			+360=	
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1000

APPLICATION AS AMENDED – PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X$ 25 =		OR	X$50 =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X100 =		OR	X200 =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					+180=		OR	+360=	
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X$ 25 =		OR	X$50 =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X100 =		OR	X200 =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					+180=		OR	+360=	
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Adam J.G. Ellison	Examiner: TBA	
Serial No:		Group Art Unit: TBA	
Filed:			
For:	FINING OF BOROALUMINO SILICATE GLASSES		

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. §§ 1.56, 1.97 – 1.98

Mail Stop Amendment
Commissioner of Patents
Alexandria, VA 22313-1450

Dear Sir:

The Examiner's attention is hereby directed to the following reference(s) listed on the attached Form PTO-1449 for consideration in connection with the examination of the above-identified patent application. [One copy of any non-US patent is enclosed.]

This submission does not represent that a search has been made or that no better art exists and does not constitute an admission that each or all of the enclosed documents constitute "prior art." If it should be determined that any of the submitted documents do not constitute "prior art" under United States law, applicant(s) reserve the right to present to the office the relevant facts and law regarding the appropriate status of such documents.

Applicant(s) further reserve the right to take appropriate action to establish the patentability of the disclosed invention over the enclosed references, should one or more of the references be applied against the claims of the present application.

Respectfully submitted,

Thomas R. Beall
Registration No. 40,424
Corning Incorporated
SP-TI-03-1
Corning, NY 14831
607-974-3921
Date: June 28, 2006

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to Mail Stop Amendment, Commissioner of Patents, P.O. Box 1450, Alexandria, Va 22313-1450 on June 28, 2006.
Date of Deposit

Thomas R. Beall
Name of applicant, assignee, or Registered Representative

Signature

June 28, 2006
Date of Signature

FORM PTO-1449 (MODIFIED) LIST OF PATENTS AND PUBLICATIONS FOR APPLICANTS INFORMATION DISCLOSURE STATEMENT	ATTORNEY DOCKET NO. ADP-231 (SP05-073)	SERIAL NO.
	APPLICANT Adam J.G. Ellison	
	FILING DATE	GROUP: TBA

REFERENCE DESIGNATION U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Sub-Class	Filing Date if Approp.
	AA	3,338,696	08-29-67	Stuart M. Dockerty	65	145	
	AB	3,682,609	08-08-72	Stuart M. Dockerty	65	83	
	AC	5,374,595	12-20-94	W.H. Dumbaugh et al.	501	66	
	AD	5,785,726	07-28-98	W.G. Dorfeld et al.	65	134.1	
	AE	5,824,127	10-20-98	James C. Bange et al.	65	90	
	AF	6,128,924	10-10-00	James C. Bange et al.	65	90	
	AG	6,319,867	11-20-01	Lisa C. Chacon et al.	501	66	
	AH						
	AI						
	AJ						
	AK						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Sub-Class	Translation Yes	Translation No
	AL	RU642265	01-15-79	Russia			X	
	AM							
	AN							
	AO							
	AP							
	AQ							

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)

	AR	
	AS	
	AT	
	AU	
	AV	
	AW	

EXAMINER: DATE CONSIDERED:

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609: draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

PATENT
Attorney Docket No.: ADP-231 (SP05-073)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Adam J.G. Ellison	Examiner: TBA	
Serial No:		Group Art Unit: TBA	
Filed:			
For:	FINING OF BOROALUMINO SILICATE GLASSES		

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In addition to the prior art of record in this application, including the publications specifically mentioned in the application and/or listed in one or more forms PTO-1449 being submitted in this case, the Examiner's attention is also invited to the following non-art document(s) consisting of one or more co-pending U. S. patent applications assigned to the assignee of the present application:

Serial No.	Applicant(s)	Filing Date
11/116,669	DeAngelis et al.	04/27/2005

While the claims of the above-listed application(s) generally relate to the ceramic arts, it is the position of the Applicant(s) that the claims of the present application cover only subject matter that is patentably distinct therefrom.

Respectfully submitted,

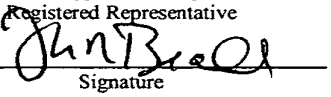


Thomas R. Beall
Registration No. 40,424
Corning Incorporated
SP-TI-03-1
Corning, NY 14831
607-974-3921

Date: June 28, 2006

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Va 22313-1450 on June 28, 2006
Date of Deposit

Thomas R. Beall
Name of applicant, assignee, or Registered Representative



Signature

June 28, 2006
Date of Signature

FORM PTO-1449 (MODIFIED) LIST OF PATENTS AND PUBLICATIONS FOR APPLICANTS INFORMATION DISCLOSURE STATEMENT	ATTORNEY DOCKET NO. ADP-231 (SP05-073)	SERIAL NO.
	APPLICANT Adam J.G. Ellison	
	FILING DATE	GROUP: TBA

REFERENCE DESIGNATION U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Sub-Class	Filing Date if Approp.
	AA	11/116,669		G. DeAngelis et al.			04/27/05
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Sub-Class	Translation Yes	No
	AL							
	AM							
	AN							
	AO							
	AP							
	AQ							

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)

	AR	
	AS	
	AT	
	AU	
	AV	
	AW	

EXAMINER: DATE CONSIDERED:

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609: draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Code: 1035-41127

Union of Socialist Soviet Republics

USSR State Committee
on Matters of Inventions and Discoveries

DESCRIPTION OF INVENTION
for Inventor's Certificate 642265

Intl. Cl.[2]:	C 03 C 3/10
UDC:	666.112.7
Registration No.:	2401625/29-33
Application Date:	September 15, 1976
Disclosure Date:	January 15, 1979, Bulletin No. 2
Publication Date of Description:	January 15, 1979

GLASS

Inventors: V. Kh. Nikulin,
L. M. Prusakova,
L. F. Yurkov,
I. A. Levin,
O. S. Nevrova and
L. N. Finarev

The invention relates to compositions of tungsten and molybdenum glasses, which are used, for example, in the manufacture of parts of three-phase metal halide lamps, the

envelopes of which must have elevated for thermal stability and softening point.

This glass can be used in electric, radio and lighting technology.

There are known refractory glasses of the aluminosilicate system for joining to tungsten and molybdenum having the following composition, wt%:

SiO_2	54-65
Al_2O_3	15-22
CaO and MgO together	7-30
PbO	10 [1]

Closest in technical essence and end result to the described glass is a glass of the following composition, wt%:

SiO_2	55-70
B_2O_3	0-10
Al_2O_3	13-25
RO	10-25

where RO is at least one oxide from the group MgO, CaO, SrO, BaO [2].

Shortcomings of these glasses are insufficient thermal stability and darkening along with solarization of the glasses during use.

The goal of the invention is an improvement of thermal stability and prevention of solarization of the glass.

To achieve this goal, the known glass, which contains SiO_2, B_2O_3, Al_2O_3, CaO, MgO and BaO, additionally contains at least one oxide from the group As_2O_3, Sb_2O_3, SO_3, SnO_2 and CeO_2 in the following ratio of components, wt%:

SiO_2	55-65
B_2O_3	5-18
Al_2O_3	10-19
CaO	1-8
MgO	0.5-4
BaO	7-15
at least one oxide from the group As_2O_3, Sn_2O_3, SO_3, SnO_2 and CeO_2,	0.1-1.5

Table 1 gives specific examples of glass compositions.

The physicochemical properties of the glassese are given in Table 2.

A batch of the above composition is weighed out in the following order: sand, barite, magnesium carbonate, chalk, boric acid, alumina, barium carbonate, antimony trioxide.

The mixture is mixed in a rotary mixer for 5 minutes and tested for uniformity with respect to boric anhydride.

Cooking of the glass is done in a gas furnace with a capacity of 1.8 t at 1570-1590°C.

Items were made in the form of bead molds and tubes of various kinds as well as cylinders 110-120 mm in diameter and up to 750 mm long.

The glasses have improved thermal stability, do not change light transmission in use, and also have improved technological properties: the tendency toward crystallization is reduced, which assures vacuum-tight joints with tungsten or molybdenum.

This set of properties assures the production of articles, in particular cylinders for gas discharge lamps, that withstand

elevated thermal loads (cylinder temperature to 600°C) and sharp changes of temperature (when heating is switched off and under the effect of atmospheric precipitation).

Table 1.

Окислы	Состав стекла, вес.%			
	1	2	3	4
SiO_2	55,0	56,50	55,0	64,5
B_2O_3	17,5	9,50	10,0	5,0
Al_2O_3	17,0	17,00	17,5	10,0
CaO	2,0	5,00	5,0	4,5
MgO	1,0	2,50	2,5	0,5
BaO	7,0	8,50	8,5	15,0
SnO_2	0,5	-	0,5	-
CeO_2	-	-	0,5	0,5
As_2O_3	-	0,35	-	-
SO_3	-	0,65	-	-
Sb_2O_3	-	-	0,5	-

Key: 1 Oxides
2 Composition of glass, wt%

Table 2.

Свойства стекол (1)	Состав стекла (2) 1	2	3	4
КЛТР 10^{70}, $°C^{-1}$ (3)	36,0	39,0	38,5	37,0
Температура размягчения, °C (4)	680	775	760	820
Термостойкость, град °C (5)	255	232	225	220
Светопропускание, %, на длине волны, нм				
260	0	0	0	0
280	3,0	0	0	0
300	19,1	2,0	0	0
320	49,4	19,2	2,0	0,3
340	72,5	53,0	53,3	33,5
360	83,5	77,0	83,0	73,1

Key: 1 Properties of glasses
2 Composition of glass
3 Coefficient of linear thermal expansion 10^{70}, $°C^{-1}$
4 Softening point, °C
5 Thermal stability, °C
6 Light transmission, %, at wavelength, mm

Claims

A glass that contains SiO_2, B_2O_3, Al_2O_3, CaO, MgO, BaO, which is distinguished by the fact that, with the goal of improving thermal stability and preventing solarization of the glass, it additionally contains at least oxide from the group: As_2O_3, Sb_2O_3, SO_3, SnO_2, CeO_2, in the following ratio of components, wt%:

SiO_2	55-65
B_2O_3	5-18
Al_2O_3	10-19

CaO	1-8
MgO	0.5-4
BaO	7-15
and at least oxide from the group As_2O_3, Sb_2O_3, SO_3, SnO_2, CeO_2,	0.1-1.5

Sources of Information Considered in Examiner's Appraisal:

1. British Patent No. 962568, cl. C 1 M, 1974.
2. British Patent No. 1168270, cl. C 1 M, 1969.

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	ADP-231 (SP05-073)	Total Pages	2
First Named Inventor or Application Identifier: Adam J.G. Ellison			
Title : FINING OF BOROALUMINO SILICATE GLASSES			
Express Mail Label No.	EV327193183US		

CERTIFICATE OF EXPRESS MAIL UNDER 37 CFR 1.10:

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated below and is Addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

on June 28, 2006 (Date)

Signature _____ Thomas R. Beall

"EXPRESS MAIL" Mailing Label No. EV327193183US

ADDRESS TO:

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

1. ☒ * Fee Transmittal Form *(Submit an original and a duplicate for fee processing)*
2. ☒ Specification [*Total Pages* 33] *(preferred arrangement set forth below)*
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R&D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings (if filed)
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. ☒ Drawing(s) *(35 U.S.C. § 113)* [*Total Sheets* 3]
4. Oath or Declaration [*Total Pages* 2]
   a. ☒ Executed (original or copy)
   b. ☐ Copy from a prior application (37 C.F.R. § 1.63(d)) *(for continuation/divisional with Box 16 completed)*
      i. ☐ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).
5. ☐ Microfiche Computer Program *(Appendix)*
6. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. ☐ Computer Readable Copy
   b. ☐ Paper Copy (identical to computer copy)
   c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. ☒ Assignment Papers (cover sheet & document(s))
8. ☒ 37 C.F.R. § 3.73(b) Statement *(when there is an assignee)* ☒ Power of Attorney
9. ☐ English Translation Document *(if applicable)*
10. ☒ Information Disclosure Statement (IDS)/PTO-1449 ☒ Copies of IDS Citations
11. ☐ Preliminary Amendment
12. ☒ Return Receipt Postcard (MPEP 503) *(should be specifically itemized)*
14. ☐ Certified Copy of Priority Document(s) *(if foreign priority is claimed)* 15. ☐ Other:

16. **If a CONTINUING APPLICATION**, *check appropriate box, and supply the requisite information below and in a preliminary amendment:*

☐ Continuation ☐ Divisional. ☐ Continuation-in-part (CIP) of prior application No

Prior application information: *Examiner:* *Group / Art Unit:*

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

☒ *Customer Number or Bar Code Label* 22928 *or* ☐ *Correspondence address below*

NAME	Thomas R. Beall				
ADDRESS	Corning Incorporated, SP-TI-3-1				
CITY	Corning	STATE	NY	ZIP CODE	14831
COUNTRY	USA	TELEPHONE	607-974-3921	FAX	(607) 974-3848
Name (Print/Type)	Thomas R. Beall		Registration No. (Attorney/Agent)		40,424
Signature			Date	June 28, 2006	

FEE TRANSMITTAL for FY 2005

Complete if Known	
Application Number	To Be Assigned
Filing Date	Herewith
First Named Inventor	Adam J.G. Ellison
Examiner Name	To Be Assigned
Group / Art Unit	To Be Assigned
Attorney Docket Number	ADP-231 (SP05-073)

TOTAL AMOUNT OF PAYMENT	($)1,000.00

METHOD OF PAYMENT (check one)

1. ☒ The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

Deposit Account Number: 03-3325

Deposit Account Name: Corning Incorporated

☒ Charge Any Additional Fees Required Under 37 C.F.R. §§ 1.16 and 1.17

2. ☐ **Payment Enclosed:**
☐ Check ☐ Money Order ☐ Other

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEE

Application Type	Filing Fee	Search Fee	Exam Fee	Fee
Utility	300	500	200	1,000.00
Design	200	100	130	
Plant	200	300	160	
Reissue	300	500	600	
Provisional	200	0	0	
SUBTOTAL (1)				($)1,000.00

2. EXCESS CLAIM FEES

	Extra Claims	Fee from below	Fee Paid
Total Claims	20 - 20** =	0 x 50 =	00.00
Independent Claims	3 - 3** =	0 x 200 =	00.00
Multiple Dependent		360 =	0.00

***or number previously paid, if greater; For Reissues, see below*

Large Fee Code	Entity Fee ($)	Fee Description
1202	50	Claims in excess of 20
1201	200	Independent claims in excess of 3
1203	360	Multiple dependent claim, if not paid0
1204	200	** Reissue independent claims over original patent
1205	50	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($)00.00

FEE CALCULATION (continued)

3. APPLICATION SIZE FEE

1081	250	Utility application size fee (for each additional 50 sheets that exceeds 100 pages)
1082	250	Design application size fee (for each additional 50 sheets that exceeds 100 pages)
1083	250	Plant application size fee (for each additional 50 sheets that exceeds 100 pages)
1084	250	Reissue application size fee (for each additional 50 sheets that exceeds 100 pages)
1085	250	Provisional application size fee (for each additional 50 sheets that exceeds 100 pages)

4. OTHER FEES

Fee Code	Large Entity Fee ($)	Fee Description	Fee Paid
1051	130	Surcharge - late filing fee or oath	
1052	50	Surcharge - late provisional filing fee or cover sheet	
1053	130	Non-English specification	
1812	2,520	For filing a request for reexamination	
1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	Requesting publication of SIR after Examiner action	
1251	120	Extension for reply within first month	
1252	450	Extension for reply within second month	
1253	1,020	Extension for reply within third month	
1254	1,590	Extension for reply within fourth month	
1255	2,160	Extension for reply within fifth month	
1401	500	Notice of Appeal	
1402	500	Filing a brief in support of an appeal	
1403	1,000	Request for oral hearing	
1451	1,510	Petition to institute a public use proceeding	
1452	500	Petition to revive - unavoidable	
1453	1,500	Petition to revive - unintentional	
1501	1,400	Utility issue fee (or reissue)	
1502	800	Design issue fee	
1503	1,000	Plant issue fee	
1462	400	Petitions to the Director not specifically provided for (Group I) 1.17(f)	
1463	200	Petitions to the Director not specifically provided for (Group II) 1.17(g)	
1464	130	Petitions to the Director not specifically provided for (Group III) 1.17(h)	
1807	50	Petitions related to provisional applications	
1806	180	Submission of Information Disclosure Stmt	
8021	40	Recording each patent assignment per property (times number of properties)	
1809	790	Filing a submission after final rejection (37 C.F.R. § 1.129(a))	
1810	790	For each additional invention to be examined (37 C.F.R § 1.129(b))	
1801	790	Request for Continued Examination (RCE)	
1802	900	Request for expedited examination of a design application	

*Reduced by Basic Filing Fee Paid SUBTOTAL (3) ($)

SUBMITTED BY		Completed (if applicable)	
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Signature		Date	June 28, 2006

PATENT
ATTORNEY DOCKET: ADP-231 (SP05-073)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Adam J.G. Ellison

AUTHORIZATION TO ACT IN A REPRESENTATIVE CAPACITY

Serial No.:

Filed:

For: FINING OF BOROALUMINO SILICATE GLASSES

Group Art Unit: TBA

Examiner: TBA

COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450

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The practitioner named below is authorized to conduct interviews and has the authority to bind the principal concerned. Furthermore, the practitioner is authorized to file correspondence in the above-identified application pursuant to 37 CFR 1.34:

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This is not a Power of Attorney to the above-named practitioner. Accordingly, the practitioner named above does **not** have authority to sign a request to change the correspondence address, a request for an express abandonment, a disclaimer, a power of attorney, or other documents requiring the signature of the application, assignee of the entire interest or an attorney of record. If appropriate, a separate Power of Attorney to the above-identified named practitioner should be executed and filed in the United States Patent and Trademark Office.

June 28, 2006
Date

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ADP-231 (SP05-073)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Adam J.G. Ellison, et al	
Serial No:	11/478493	Examiner: TBA
Filed:	June 28, 2006	Group Art Unit: 1756
For:	FINING OF BOROALUMINO SILICATE GLASSES	

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. §§ 1.56, 1.97 – 1.98

Mail Stop Amendment
Commissioner of Patents
Alexandria, VA 22313-1450

Dear Sir:

The Examiner's attention is hereby directed to the following reference(s) listed on the attached Form PTO-1449 for consideration in connection with the examination of the above-identified patent application. One copy of any non-US patent is enclosed.

Each of the enclosed reference(s) was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement.

This submission does not represent that a search has been made or that no better art exists and does not constitute an admission that each or all of the enclosed documents constitute "prior art." If it should be determined that any of the submitted documents do not constitute "prior art" under United States law, applicant(s) reserve the right to present to the office the relevant facts and law regarding the appropriate status of such documents.

Applicant(s) further reserve the right to take appropriate action to establish the patentability of the disclosed invention over the enclosed references, should one or more of the references be applied against the claims of the present application.

Respectfully submitted,

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I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to Mail Stop Amendment, Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on September 28, 2006.
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Revision: September 1, 2002
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FORM PTO-1449 (MODIFIED) LIST OF PATENTS AND PUBLICATIONS FOR APPLICANTS INFORMATION DISCLOSURE STATEMENT	ATTORNEY DOCKET NO. ADP-231 (SP05-073)	SERIAL NO. 11/478493
	APPLICANT Adam J.G. Ellison, et al.	
	FILING DATE June 28, 2006	GROUP: 1756

REFERENCE DESIGNATION U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Sub-Class	Filing Date if Approp.
	AA	2003/0121288	07-03-03	Jun Naka et al.	65	134.3	
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Sub-Class	Translation Yes	Translation No
	AL	EP 0 607 865	07-27-94	Europe			X	
	AM							
	AN							
	AO							
	AP							
	AQ							

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)

	AR	
	AS	
	AT	
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EXAMINER: DATE CONSIDERED:

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609: draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 607 865 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **94100407.9**

(51) Int. Cl.5: **C03C 3/091**

(22) Date of filing: **13.01.94**

(30) Priority: **22.01.93 US 8560**
22.11.93 US 155483

(43) Date of publication of application:
27.07.94 Bulletin 94/30

(84) Designated Contracting States:
BE DE FR GB IT NL

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(54) High liquidus viscosity glasses for flat panel displays.

(57) This invention is related to glasses for use as substrates in flat panel display devices; more specifically, for use as substrates in LCDs which utilize polycrystalline silicon thin film transistors. The compositions for the inventive glasses are essentially free from alkali metal oxides and consist essentially, in mole percent, of

SiO_2	64-70	Y_2O_3	0-5
Al_2O_3	9.5-14	MgO	0-5
B_2O_3	5-10	CaO	3-13
TiO_2	0-5	SrO	0-5.5
Ta_2O_5	0-5	BaO	2-7
Nb_2O_5	0-5	MgO + CaO + SrO + BaO	10-20 .

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This invention is directed to the production of glass compositions exhibiting high viscosities at their liquidus temperatures. More particularly, this invention is directed to such glasses demonstrating chemical and physical characteristics rendering them especially suitable for use as substrates in flat panel display devices.

Liquid crystal displays (LCDs) are passive displays which depend upon external sources of light for illumination. They are manufactured as segmented displays or in one of two basic configurations. The substrate needs (other than being transparent and capable of withstanding the chemical conditions to which it is exposed during display processing) of the two matrix types vary. The first type is intrinsic matrix addressed, relying upon the threshold properties of the liquid crystal material. The second is extrinsic matrix or active matrix (AM) addressed, in which an array of diodes, metal-insulator-metal (MIM) devices, or thin film transistors (TFTs) supplies an electronic switch to each pixel. In both cases, two sheets of glass form the structure of the display. The separation between the two sheets is the critical gap dimension, of the order of 5-10 μm.

Intrinsically addressed LCDs are fabricated using thin film deposition techniques at temperatures ≤350°C, followed by photolithographic patterning. As a result, the substrate requirements therefor are often the same as those for segmented displays. Soda-lime-silica glass with a barrier layer has proven to be adequate for most needs. A high performance version of intrinsically addressed LCDs, the super twisted nematic (STN) type, has an added requirement of extremely precise flatness for the purpose of holding the gap dimensions uniform. Because of that requirement, soda-lime-silica glass used for those displays must be polished or, alternatively, a precision formed, barium aluminoborosilicate glass marketed by Corning Incorporated, Corning, New York, as Code 7059 may be used without polishing.

Extrinsically addressed LCDs can be further subdivided into two categories; viz., one based on MIM or amorphous silicon (a-Si) devices, and the other based on polycrystalline silicon (poly-Si) devices. The substrate requirements of the MIM or a-Si type are similar to the STN application. Corning Code 7059 sheet glass is the preferred substrate because of its very low sodium content, i.e., less than 0.1% Na_2O by weight, its dimensional precision, and its commercial availability. Devices formed from poly-Si, however, are processed at higher temperatures than those that are employed with a-Si TFTs. Substrates capable of use temperatures (taken to be 25°C below the strain point of the glass) of 600°-800°C are demanded. The actual temperature required is mandated by the particular process utilized in fabricating the TFTs. Those TFTs with deposited gate dielectrics require 600°-650°C, while those with thermal oxides call for about 800°C. Both a-Si and poly-Si processes demand precise alignment of successive photolithographic patterns, thereby necessitating that the thermal shrinkage of the substrate be kept low. Those temperatures have mandated the use of glasses exhibiting higher strain points than soda-lime-silica glass and Corning Code 7059 glass in order to avoid thermal deformation of the sheet during processing. As can be appreciated, the lower the strain point, the greater this dimensional change. Thus, there has been considerable research to develop glasses demonstrating high strain points so that thermal deformation is minimized during device processing at temperatures greater than 600°C, and preferably, higher than 650°C.

U. S. Patent No. 4,824,808 (Dumbaugh, Jr.) lists four properties which have been deemed mandatory for a glass to exhibit in order to fully satisfy the needs of a substrate for LCDs:

First, the glass must be essentially free of intentionally added alkali metal oxide to avoid the possibility that alkali metal from the substrate can migrate into the transistor matrix;

Second, the glass substrate must be sufficiently chemically durable to withstand the reagents used in the TFT matrix deposition process;

Third, the expansion mismatch between the glass and the silicon present in the TFT array must be maintained at a relatively low level even as processing temperatures for the substrates increase; and

Fourth, the glass must be capable of being produced in high quality thin sheet form at low cost; that is, it must not require extensive grinding and polishing to secure the necessary surface finish.

That last requirement is most difficult to achieve inasmuch as it demands a sheet glass production process capable of producing essentially finished glass sheet, such as the overflow downdraw sheet manufacturing process described in U. S. Patent No. 3,338,696 (Dockerty) and U. S. Patent No. 3,682,609 (Dockerty). That process requires a glass exhibiting a very high viscosity at the liquidus temperature plus long term stability, e.g., periods of 30 days, against devitrification at melting and forming temperatures.

Corning Code 7059 glass, supra, is currently employed in the fabrication of LCDs. That glass, consisting essentially, in weight percent, of about 50% SiO_2, 15% B_2O_3, 10% Al_2O_3, and 24% BaO, is nominally free of alkali metal oxides, and exhibits a linear coefficient of thermal expansion (25°-300°C) of about 46 X 10^{-7}/°C and a viscosity at the liquidus temperature in excess of 600,000 poises (6 x 10^4 Pa•s). The high liquidus viscosity of the glass enables it to be drawn into sheet via the overflow downdraw sheet

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processing technique, but its relatively low strain point (~593 °C) is adequate only for processing a-Si devices and not for poly-Si devices.

The glasses of U. S. Patent No. 4,824,808, supra, were designed to meet the requirements for use in fabricating poly-Si devices, including the capability of being formed into sheet by the overflow downdraw sheet processing technique, and linear coefficients of thermal expansion as low as about 36.5 X 10^{-7}/°C (25°-300°C), such as to closely match that of silicon, thereby enabling a silicon chip to be sealed directly thereon, but their strain points were less than 650°C.

The glasses of U. S. Patent No. 4,409,337 (Dumbaugh, Jr.) were also considered for LCD substrates, but their long term stability against devitrification was feared to be insufficient for their use in the overflow downdraw sheet processing technique.

The glasses of U. S. Patent No. 5,116,787 (Dumbaugh, Jr.) are essentially free from alkali metal oxides and MgO and demonstrate strain points of 655°C and higher, with viscosities at the liquidus greater than 1.5 X 10^5 poises (1.5 X 10^4 Pa•s). Although designed for use in the overflow downdraw sheet processing technique, their long term stability against devitrification was found to be marginal when employed in the process, some crystallization being formed in the glass during manufacture. Also, the linear coefficients of thermal expansion (25°-300°C) generally ranged in the upper 40s to low 50s X 10^{-7}/°C, undesirably high for matching that of silicon (~35 X 10^{-7}/°C).

U. S. Patent No. 5,116,788 (Dumbaugh, Jr.) discloses other glasses exhibiting high strain points, i.e., greater than 675°C, but having such relatively low viscosities at the liquidus temperature, viz., 20,000-200,000 poises (2,000-20,000 Pa•s), as to be subject to devitrification when formed utilizing the overflow downdraw sheet processing technique.

Finally, U. S. Patent No. 5,116,789 (Dumbaugh, Jr. et al.) describes other glass compositions demonstrating strain points higher than 675°C, but their linear coefficients of thermal expansion (25°-300°C) range from 45-62 X 10^{-7}/°C, too high to form a high temperature match with silicon.

A recent advance in liquid crystal technology termed "chip-on-glass" (COG) has further emphasized the need for the substrate glass to closely match silicon in thermal expansion. Thus, the initial LCD devices did not have their driver chips mounted on the substrate glass. Instead, the silicon chips were mounted remotely and were connected to the LCD substrate circuitry with compliant or flexible wiring. As LCD device technology improved and as the devices became larger, these flexible mountings became unacceptable, both because of cost and of uncertain reliability. This situation led to Tape Automatic Bonding (TAB) of the silicon chips. In that process the silicon chips and electrical connections to the chips were mounted on a carrier tape, that subassembly was mounted directly on the LCD substrate, and thereafter the connection to the LCD circuitry was completed. TAB decreased cost while improving reliability and increasing the permitted density of the conductors to a pitch of approximately 200 μm -- all significant factors. COG, however, provides further improvement over TAB with respect to those three factors. Hence, as the size and quality requirements of LCD devices increase, COG is demanded for those devices dependent upon the use of integrated circuit silicon chips. For that reason, the substrate glass must demonstrate a linear coefficient of thermal expansion closely matching that of silicon; i.e., the glass must exhibit a linear coefficient of thermal expansion (0°-300°C) between 32-46 X 10^{-7}/°C, most preferably 32-40 X 10^{-7}/°C.

Summary of the Invention

The present invention is founded in the discovery of glass exhibiting linear coefficients of thermal expansion over the temperature range of 0°-300°C between 32-46 X 10^{-7}/°C, strain points higher than 650°C, liquidus temperatures no higher than 1200°C, liquidus viscosities greater than about 200,000 poises (20,000 Pa•s), a weight loss of less than 2 mg/cm^2 after immersion for 24 hours in an aqueous 5% by weight HCl solution at 95°C, long term stability against devitrification at melting and forming temperatures, and melting viscosities of about 200 poises (20 Pa•s) at less than 1675°C, the glasses being essentially free from alkali metal oxides and consisting essentially, expressed in terms of mole percent on the oxide basis, of

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SiO_2	64-70	Y_2O_3	0-3
Al_2O_3	9.5-14	MgO	0-5
B_2O_3	5-10	CaO	3-13
TiO_2	0-5	SrO	0-5.5
Ta_2O_5	0-5	BaO	2-7
Nb_2O_5	0-5	MgO + CaO + SrO + BaO	10-20

Because of their deleterious effect upon the electrical properties of the glasses, the alkali metal oxides will most preferably be totally absent therefrom.

Adherence to those composition intervals has been found to be vital in securing glasses demonstrating properties desired for LCD substrate glasses to be employed in poly-Si devices. To illustrate:

If the SiO_2 content is below 64%, the strain point will be too low and the resistance of the glass to attack by acid will be poor. On the other hand, when the concentration of SiO_2 exceeds 70%, the glass becomes difficult to melt at customary glass melting temperatures.

The level of Al_2O_3 is critical to obtain a minimum liquidus temperature; that is, if the concentration of Al_2O_3 falls below 9.5% or exceeds 14%, the liquidus temperature can exceed 1200°C.

B_2O_3 tends to improve the viscosity character of the glass thereby making it easier to process. Where the level of B_2O_3 is less than 5%, the liquidus temperature becomes too high. At contents above 10% B_2O_3, the resistance to attack by acid is sacrificed and the strain point becomes too low.

The alkaline earth metal oxides modify the melting and physical properties of the glass. If the total thereof exceeds 20%, however, the linear coefficient of thermal expansion becomes too high. SrO and BaO raise the thermal expansion more than either MgO or CaO and, hence, will individually not exceed 7%. Because CaO also raises the thermal expansion, but at a slower rate than SrO or BaO, the total thereof ought not to exceed 13%. MgO appears to exert a beneficial effect upon the liquidus temperature at low levels, but, at concentrations greater than 5%, the liquidus temperature appears to rise.

The inclusion of TiO_2 is useful in lowering the coefficient of thermal expansion of the glass. The presence of Ta_2O_5 not only lowers the coefficient of thermal expansion of the glass but also raises the strain point of the glass and significantly improves the chemical durability thereof. Nb_2O_5 and Y_2O_3 appear to reduce the coefficient of thermal expansion of the glass and lower the liquidus temperature thereof.

In the preferred glasses the level of Al_2O_3 will exceed that of B_2O_3 and in the most preferred glasses the composition will consist essentially, expressed in terms of mole percent, of about

SiO_2	65-69	MgO	1-5
Al_2O_3	10-12	CaO	3-9
B_2O_3	7-10	SrO	1-3
TiO_2	0-3	BaO	2-5
Ta_2O_5	0-3	MgO + CaO + SrO + BaO	11-16

wherein the ratio Al_2O_3: B_2O_3 >1. The glasses will exhibit a linear coefficient of thermal expansion (0°-300°C) of 32-40X10^{-7}/°C a liquidus temperature no higher than 1125°C and a viscosity at the liquidus temperature greater than 600,000 poises (60,000 Pa•s).

Description of Preferred Embodiments

Table I records a number of glass compositions, expressed in terms of parts by weight on the oxide basis, illustrating the compositional parameters of the present invention. Inasmuch as the sum of the individual constituents totals or very closely approximates 100, for all practical purposes the reported values may be deemed to represent weight percent. The actual batch ingredients may comprise any materials, either oxides or other compounds, which, when melted together with the other batch components, will be converted into the desired oxide in the proper proportions. For example, $SrCO_3$ and $CaCO_3$ can provide the source of SrO and CaO, respectively.

The batch ingredients were compounded, tumble mixed together thoroughly to aid in producing a homogeneous melt, and charged into platinum crucibles. After placing lids thereon, the crucibles were moved into furnaces operating at temperatures of 1600°-1650°C. To assure the production of inclusion- and cord-free glasses a two step melting procedure was used. In the first step the batch was melted for about 16 hours, stirred and then poured as a fine stream into a water bath, a process termed "drigaging" in

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the glass art. In the second step the finely-divided glass particles from the drigaging were remelted at 1600°-1650°C for about four hours, the melts stirred in both directions (clockwise and counterclockwise), the melts thereafter poured onto steel plates to make glass slabs having dimensions of about 18" X 6" X 0.5" (~45.7 X 15.2 X 1.3 cm), and those slabs transferred immediately to an annealer operating at about 730°C.

Whereas the above description reflects a laboratory melting procedure, it must be appreciated that the inventive glasses are capable of being melted and formed employing large scale, commercial glass melting and forming equipment. Thus, the glasses are specifically designed to be drawn into thin sheet utilizing the overflow downdraw sheet processing technique. For the experimental glasses described herein, arsenic and/or antimony in amounts of about 0-1% and 0-0.5%, respectively, were added to each batch to perform their customary function as a fining agent. The small residual remaining in the glass has no substantial effect upon the properties of the glass.

Table I also lists measurements of several chemical and physical properties determined on the glasses in accordance with techniques conventional in the glass art. Thus, the linear coefficient of thermal expansion (Exp.) over the temperature range 0°-300°C expressed in terms of X 10^{-7}/°C, and the softening point (S.P.), annealing point (A.P.), and strain point (St.P.) expressed in terms of °C, were determined by fiber elongation. The durability (Dur.) in HCl was determined by measuring the weight loss (mg/cm^2) after immersion in a bath of aqueous 5% by weight HCl at 95°C for 24 hours.

The liquidus temperatures of the glasses were measured via two different methods. The standard liquidus method (Liq.) involves placing crushed glass particles in a platinum boat, placing the boat in a furnace having a region of gradient temperatures, heating the boat in an appropriate temperature region for 24 hours, and determining by means of microscopic examination the highest temperature at which crystals appear in the interior of the glass. A second method termed the "meltback liquidus" (M.Liq.) contemplates placing a glass sample which has been precrystallized by holding at a temperature of 1000°C for 24 hours in a platinum boat, heating the boat in an appropriate temperature region in a gradient furnace for 24 hours, and then determining by microscopic examination the lowest temperature at which crystals are not observed in the interior of the glass. Generally, the liquidus temperatures measured by these two techniques do not differ by more than 50°C, with the "meltback liquidus" typically being higher than the standard liquidus temperature.

Table IA records the same glass compositions expressed in terms of mole percent on the oxide basis, the content of the fining agents being omitted as their presence in the final glass is small and has no substantive effect upon the overall properties of the glass.

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TABLE I

	1	2	3	4	5	6	7	
SiO_2	57.0	57.3	56.8	59.3	55.0	59.2	55.8	
Al_2O_3	15.1	14.7	15.3	15.7	14.5	15.6	17.3	
B_2O_3	8.57	8.61	8.55	4.89	8.28	8.90	8.59	
MgO	0.70	0.70	0.70	0.73	0.68	0.73	0.702	
CaO	7.64	7.67	7.61	7.95	10.8	4.13	6.51	
SrO	1.80	1.81	1.80	1.87	1.74	1.87	1.81	
BaO	9.11	9.15	9.08	9.48	8.79	9.45	9.13	
As_2O_3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
Sb_2O_3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Exp.	43.0	42.9	43.1	43.7	47.4	38.1	41.0	
S.P.	924	922	926	961	894	972	950	
A.P.	705	703	704	733	725	725	722	
St.P.	656	653	656	680	669	668	671	
Dur.	1.12	---	---	---	1.94	1.88	---	
M.Liq.	1075	1080	1085	1150	1080	1070	1115	
	8	9	10	11	12	13	14	15
SiO_2	57.1	57.1	59.1	58.5	57.2	57.8	56.4	59.4
Al_2O_3	14.7	14.8	15.6	15.6	16.5	15.4	16.0	17.4
B_2O_3	6.22	7.0	8.31	8.3	9.53	8.2	7.48	10.0
MgO	0.285	0.432	1.42	1.42	0.73	1.4	1.38	1.45
CaO	9.72	9.01	4.13	4.13	3.18	4.08	4.01	6.05
SrO	0.733	1.11	1.87	1.87	1.87	1.84	1.81	*0.09
BaO	11.1	10.4	9.46	9.44	9.48	9.33	9.18	5.51
TiO_2	--	--	--	0.69	1.38	--	--	--
Ta_2O_5	--	--	--	--	--	1.87	3.68	--
Exp.	45.9	44.8	37.7	37.4	35.0	38	36.5	34.6
S.P.	925	924	969	964	971	969	973	966
A.P.	713	711	723	721	725	728	739	730
St.P.	667	660	667	664	667	670	681	676
Dur.	0.3	0.4	0.86	0.7	1.28	0.6	0.28	1.6
M.Liq.	1095	1110	--	--	--	--	--	--
Liq.	--	--	1065	1060	1090	1055	1055	1085

*Impurity in $BaCO_3$ batch material. None purposely added.

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TABLE IA

	1	2	3	4	5	6	7	
SiO_2	65.4	65.6	65.3	68.0	62.7	68.5	64.8	
Al_2O_3	10.2	9.9	10.4	10.6	9.8	10.7	11.8	
B_2O_3	8.55	8.5	8.5	4.8	8.1	8.9	8.61	
MgO	1.2	1.2	1.2	1.2	1.1	1.2	1.22	
CaO	9.4	9.4	9.4	9.8	13.2	5.1	8.1	
SrO	1.2	1.2	1.2	1.2	1.1	1.2	1.22	
BaO	4.1	4.1	4.1	4.2	3.9	4.3	4.15	
	8	9	10	11	12	13	14	15
SiO_2	65.8	65.7	68.1	67.5	66.5	67.7	67.3	66.7
Al_2O_3	10.0	10.0	10.6	10.6	11.3	10.6	11.2	11.5
B_2O_3	6.19	6.95	8.26	8.26	8.96	8.29	7.71	9.70
MgO	0.49	0.74	1.25	1.25	1.26	1.25	1.26	2.42
CaO	12.0	11.1	5.1	5.1	5.16	5.11	5.13	7.27
SrO	0.49	0.74	1.25	1.25	1.26	1.25	1.26	--
BaO	5.02	4.7	4.27	4.27	4.32	4.28	4.29	2.42
TiO_2	--	--	--	0.59	1.2	--	--	--
Ta_2O_5	--	--	--	--	--	0.3	0.6	--

Example 5 illustrates how a glass with high CaO and low SiO_2 can result in high thermal expansion coefficients.

Table II records a second group of glass compositions which were characterized more in depth, again expressed in terms of parts by weight on the oxide basis. Again, because the sum of the individual constituents totals or very closely approximates 100, for all practical purposes the values recited may be considered to reflect weight percent. And, in like manner to the compositions recorded in Table I, the actual batch ingredients may comprise any materials, either oxides or other compounds, which, when melted together, will be converted into the desired oxide in the proper proportions.

The batch ingredients were compounded, mixed together, melted, and shaped into glass slabs in accordance with the laboratory procedure outlined above for the glasses of Table I.

Table II also lists the measurements of chemical and physical properties conducted on the several glasses along with two additional determinations not performed on the glasses of Table I. First, the melting temperature [Melt, in °C] (defined as the temperature at which the glass melt demonstrates a viscosity of 200 poises [20 Pa•s]) has been added, being calculated employing the Fulcher equation as fit to the high temperature viscosity data. Second, the liquidus viscosity (Visc), also calculated using the Fulcher equation coefficients, was added, expressed in terms of X 100,000 poises (10,000 Pa•s). The liquidus temperature reported was determined in accordance with the standard liquidus method (Liq.). Finally, in like manner to the glass compositions of Table I, fining of the glass was accomplished by including arsenic and/or antimony in the glass batch.

Table IIA reports the same glass compositions expressed in terms of mole percent on the oxide basis, the concentration of fining agent being omitted because the small residual therefrom has no substantive effect upon the overall properties of the glass. Example No. 16 is a laboratory remelt of Example No. 6.

BNSDOCID: <EP_____0607865A1_I_>

TABLE II

	16	17	18	19	20	21	22	23
SiO_2	59.2	57.7	59.9	58.8	59.6	58.3	58.2	57.8
Al_2O_3	15.6	15.2	15.8	15.5	15.8	16.5	16.5	17.0
B_2O_3	8.90	8.67	9.01	8.84	8.96	8.94	8.32	8.94
MgO	0.73	0.71	0.74	---	---	0.73	1.42	0.73
CaO	4.13	6.57	2.99	5.45	4.18	4.15	4.14	4.15
SrO	1.87	1.82	1.89	1.86	1.88	1.87	1.87	1.87
BaO	9.45	9.21	9.57	9.39	9.52	9.49	9.47	9.49
Exp.	37.5	42.0	36.2	39.5	37.2	38.1	37.1	37.2
S.P.	973	937	992	972	989	980	972	979
A.P.	721	707	730	722	732	731	730	735
St.P.	662	656	669	666	672	673	673	677
Dur.	0.62	1.04	0.52	0.63	0.52	0.72	1.1	1.12
Liq.	1065	1050	1085	1105	1070	1035	1020	1030
Melt	1645	1560	1670	1644	1670	1632	1619	--
Visc	21	8.8	22	6.7	32	58	79	--

	24	25	26	27	28	29	30	31
SiO_2	61.3	58.4	58.1	57.3	57.5	55.4	54.5	48.0
Al_2O_3	14.4	17.1	16.5	16.5	12.5	16.0	16.3	12.8
B_2O_3	9.8	9.85	7.11	8.35	7.5	7.07	7.22	6.73
MgO	1.42	1.43	2.8	2.12	--	4.43	3.13	--
CaO	3.95	3.97	4.13	4.15	2.5	2.37	8.23	10.8
SrO	3.65	3.67	1.87	1.88	--	7.01	--	8.58
BaO	5.4	5.42	9.45	9.5	20.0	7.78	10.6	10.7
Exp.	37.2	35.8	39.1	38.6	43.9	41.3	44.5	59.4
S.P.	970	969	953	957	917	--	908	--
A.P.	719	730	722	726	702	719	703	670
St.P.	664	674	670	676	653	674	657	627
Dur.	--	1.8	0.62	0.88	0.39	0.9	2.69	2.9
Liq.	--	1050	1075	1055	1080	1242	1086	1042
Melt	--	1610	1585	1595	1758	--	1475	--
Visc	--	29	8.0	17	14.8	--	1.0	--

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TABLE II (Cont.)

	32	33	34	35	36	37	38
SiO_2	57.5	57.2	58.2	57.1	55.69	57.3	57.3
Al_2O_3	18.2	18.6	18.4	17.6	19.6	19.0	17.9
B_2O_3	7.41	7.08	8.14	7.65	7.75	6.79	7.38
MgO	1.42	1.76	1.44	1.41	1.43	1.42	1.41
CaO	4.13	4.11	4.18	4.1	4.14	4.11	4.11
SrO	1.87	1.86	--	--	1.88	1.86	1.86
BaO	9.45	9.41	9.57	12.1	9.49	9.43	10.1
Exp.	36.9	37.2	34.9	38.1	37.6	36.6	37.8
S.P.	987	983	988	981	982	990	983
A.P.	740	740	738	734	741	749	743
St.P.	682	682	678	674	684	693	690
Dur.	0.7	0.78	0.83	0.77	1.84	0.66	0.64
Liq.	1080	1100	1090	1035	1145	1155	1090
Melt	1600	1582	1607	1597	1581	1589	1593
Visc	14	8	12	>40	2.2	2.4	11

TABLE II (Cont.)

	39	40	41	42	43	44	45	46
SiO_2	56.3	56.8	57.2	55.8	56.4	55.3	55.5	55.7
Al_2O_3	18.3	18.4	18.6	17.7	17.9	16.6	16.6	16.7
B_2O_3	6.38	6.43	6.48	6.32	6.98	7.55	7.58	7.61
MgO	1.39	1.4	1.41	1.38	1.39	2.07	2.08	2.08
CaO	4.04	4.07	5.06	4.0	4.05	4.04	4.06	4.07
SrO	1.83	3.6	1.86	1.81	--	1.83	1.84	1.84
BaO	11.83	9.33	9.4	13.0	13.4	9.26	9.3	9.33
Ta_2O_5	--	--	--	--	--	2.79	1.87	0.94
Nb_2O_5	--	--	--	--	--	0.56	1.12	1.69
Exp.	40.1	39.1	38.4	41.2	38.6	38.4	38.4	38.1
S.P.	985	986	982	978	985	957	956	951
A.P.	746	737	742	740	744	729	728	724
St.P.	690	681	688	687	690	676	674	671
Dur.	0.63	0.57	0.57	0.53	0.59	0.56	0.65	0.7
Liq.	1130	1060	1120	1140	1080	1070	1065	1070
Melt	1587	1597	1583	1586	1601	--	--	--
Visc	4	30	4.5	2.6	14	--	--	--

BNSDOCID: <EP_____0607865A1_I_>

TABLE II (Concl.)

	47	48	49	50	51
SiO_2	55.9	55.4	55.6	55.9	56.0
Al_2O_3	16.8	16.6	16.6	16.7	16.8
B_2O_3	7.64	7.56	7.6	7.63	7.65
MgO	2.09	2.07	2.08	2.09	2.1
CaO	4.09	4.05	4.06	4.08	4.1
SrO	1.85	1.83	1.84	1.85	1.85
BaO	9.37	9.27	9.31	9.35	9.38
Ta_2O_5	--	2.79	1.87	0.94	--
Nb_2O_5	2.26	--	--	--	1.13
Y_2O_3	--	0.48	0.96	1.44	0.96
Exp.	38.3	38.3	38.5	39.2	37.8
S.P.	949	961	959	958	955
A.P.	724	733	731	733	728
St.P.	671	680	679	681	676
Dur.	0.86	0.64	0.74	0.99	0.97
Liq.	1065	1055	1065	1090	1090

TABLE IIA

	16	17	18	19	20	21	22	23
SiO_2	68.5	66.4	69.5	68.2	69.4	67.7	67.3	67.3
Al_2O_3	10.7	10.3	10.8	10.6	10.8	11.3	11.2	11.6
B_2O_3	8.9	8.6	9.0	8.8	9.0	9.0	8.3	8.99
MgO	1.2	1.2	1.3	---	---	1.3	2.5	1.27
CaO	5.1	8.1	3.7	6.8	5.2	5.2	5.1	5.18
SrO	1.2	1.2	1.3	1.2	1.3	1.3	1.3	1.27
BaO	4.3	4.1	4.4	4.3	4.4	4.3	4.5	4.33

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TABLE IIA (Cont.)

	24	25	26	27	28	29	30	31
SiO_2	69.0	66.7	66.5	66.1	70.2	63.6	62.0	57.9
Al_2O_3	9.52	11.5	11.1	11.2	9.0	10.8	11.0	9.1
B_2O_3	9.52	9.7	7.03	8.31	7.9	7.0	7.0	7.0
MgO	2.38	2.42	4.79	3.65	--	7.58	5.3	--
CaO	4.76	4.85	5.07	5.13	3.27	2.91	10.0	14.0
SrO	2.38	2.42	1.24	1.26	--	4.66	--	6.0
BaO	2.38	2.42	4.24	4.29	9.57	3.49	4.7	6.0

	32	33	34	35	36	37
SiO_2	66.9	66.5	67.4	66.9	65.3	66.9
Al_2O_3	12.5	12.7	12.6	12.2	13.5	13.1
B_2O_3	7.44	7.09	8.12	7.74	7.83	6.84
MgO	2.46	3.04	2.47	2.46	2.49	2.46
CaO	5.15	5.11	5.18	5.15	5.21	5.15
SrO	1.26	1.25	--	--	1.27	1.26
BaO	4.31	4.28	4.33	5.56	4.36	4.31

TABLE IIA (Cont.)

	38	39	40	41	42	43
SiO_2	66.8	66.5	66.5	66.5	66.3	66.7
Al_2O_3	12.3	12.7	12.7	12.7	12.4	12.4
B_2O_3	7.42	6.5	6.5	6.5	6.48	7.11
MgO	2.45	2.44	2.44	2.44	2.44	2.44
CaO	5.14	5.11	5.11	6.31	5.1	5.13
SrO	1.26	1.25	2.44	1.25	1.25	--
BaO	4.6	5.47	4.28	4.28	6.05	6.14

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TABLE 11A (Concl.)

	44	45	46	47	48	29	50	51
SiO_2	65.7	65.7	65.7	65.7	65.7	65.7	65.7	65.7
Al_2O_3	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
B_2O_3	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74
MgO	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66
CaO	5.15	5.15	5.15	5.15	5.15	5.15	5.15	5.15
SrO	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
BaO	4.31	4.31	4.31	4.31	4.31	4.31	4.31	4.31
Ta_2O_5	0.45	0.3	0.15	--	0.45	0.3	0.15	--
Nb_2O_5	0.15	0.3	0.45	0.6	--	--	--	0.3
Y_2O_3	--	--	--	--	0.15	0.3	0.45	0.3

Examples 28-31 illustrate glasses having compositions close to, but somewhat outside of, the inventive ranges. Thus, the SiO_2 and BaO concentrations are too high in Example 28; the level of SiO_2 is low and that of MgO too high in Example 29; the content of SiO_2 is low in Example 30; and the amount of SiO_2 is low and that of CaO too high in Example 31.

Examples 16, 21, 22, 25, 26, and 27 constitute preferred compositions with Example 21 being the most preferred based upon its overall combination of chemical, physical, and melting properties.

Claims

1. A glass exhibiting a strain point higher than 650°C, a linear coefficient of thermal expansion over the temperature range 0°-300°C between 32-46 x 10^{-7}/°C, and a weight loss of less than 2 mg/cm^2 after immersion for 24 hours in an aqueous 5% by weight HCl solution, said glass being essentially free from alkali metal oxides and consisting essentially, expressed in terms of mole percent on the oxide basis, of

SiO_2	64-70	Y_2O_3	0-5
Al_2O_3	9.5-14	MgO	0-5
B_2O_3	5-10	CaO	3-13
TiO_2	0-5	SrO	0-5.5
Ta_2O_5	0-5	BaO	2-7
Nb_2O_5	0-5	MgO + CaO + SrO + BaO	10-20 .

2. A glass according to claim 1 wherein the liquidus temperature thereof is no higher than 1200°C.

3. A glass according to claim 1 wherein the viscosity thereof at the liquidus temperature is greater than about 20,000 Pa.s (200,000 poises).

4. A glass according to claim 1 wherein said glass exhibits a melting viscosity of about 20 Pa.s (200 poises) at a temperature below 1675°C.

5. A glass according to claim 1 wherein said glass exhibits a linear coefficient of thermal expansion between 32-40 x 10^{-7}/°C.

6. A glass according to claim 1 wherein said glass consists essentially of

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SiO_2	65-69	Y_2O_3	0-3
Al_2O_3	10-12	MgO	1-5
B_2O_3	7-10	CaO	3-9
TiO_2	0-3	SrO	1-3
Ta_2O_5	0-3	BaO	2-5
Nb_2O_5	0-3	MgO + CaO + SrO + BaO	11-16

wherein the ratio $Al_2O_3:B_2O_3>1$.

7. A glass according to claim 6 wherein the liquidus temperature thereof is no higher than 1125 °C.

8. A glass according to claim 6 wherein the viscosity thereof at the liquidus temperature is greater than 60,000 Pa.s (600,000 poises).

9. Use of the glass according to any one of claims 1-11 as a substrate for a flat panel display device.

10. Use of the glass, according to claim 5 or 6, as a substrate for a flat panel display device, wherein silicon chips are mounted directly on said glass utilizing "chip-on-glass" technology.

BNSDOCID: <EP_____0607865A1_I_>

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 10 0407

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 016, no. 455 (C-0987)22 September 1992 & JP-A-04 160 030 (HOYA CORP) 3 June 1992 * abstract; example 3 *	1-10	C03C3/091
X	EP-A-0 510 543 (ASAHI GLASS COMPANY) * page 2, line 42 - page 3, line 30; example 2 *	1-10	
D,X	US-A-5 116 787 (DUMBAUGH, JR.) * column 2, line 51 - column 4, line 26; table II *	1-10	
X	PATENT ABSTRACTS OF JAPAN vol. 014, no. 363 (C-0746)7 August 1990 & JP-A-02 133 334 (CENTRAL GLASS CO LTD) 22 May 1990 * abstract *	1-10	
A	DE-A-37 30 410 (NIPPON ELECTRIC GLASS CO.) * the whole document *	1-10	TECHNICAL FIELDS SEARCHED (Int.Cl.5)
A	FR-A-2 675 795 (NIPPON SHEET GLASS CO.) * page 3, line 13 - page 6, line 19; table 1 *	1-10	C03C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 April 1994	Van Bommel, L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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APPLICATION NUMBER	FILING OR 371(c) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)

CONFIRMATION NO. 5778

22928
CORNING INCORPORATED
SP-TI-3-1
CORNING, NY14831

Title: Fining of boroalumino silicate glasses

Publication No. US-2006-0293162-A1
Publication Date: 12/28/2006

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Adam J.G. Ellison	
Serial No:	11/478,493	Group Art Unit: 1756
Filed:	June 28, 2006	Examiner: TBA
For:	FINING OF BOROALUMINO SILICATE GLASSES	Docket No. SP05-073

Commissioner of Patents
Alexandria, VA 22313-1450

Sir:

STATUS INQUIRY

Applicants hereby request the status of the above referenced pending application and a projected date for the next action.

October 16, 2007
Date

CERTIFICATE OF MAILING (37 CFR 1.8a)

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on

October 16, 2007
Date

Thomas R. Beall — October 16, 2007
Thomas R. Beall — Date

Respectfully submitted,
CORNING INCORPORATED

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Revision: September 1, 2002
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)	5778

22928 7590 01/23/2008
CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

EXAMINER	
HOBAN, MATTHEW E	
ART UNIT	PAPER NUMBER
4116	
MAIL DATE	DELIVERY MODE
01/23/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	11/478,493	ELLISON, ADAM J.G.	
	Examiner	Art Unit	
	Matthew E. Hoban	4116	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *1* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *28 June 2006*.

2a)☐ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) _____ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☒ Claim(s) *1-20* are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

   I. Claims 1-17, drawn to a composition of alkali-free glass, classified in class 501, subclass 70.

   II. Claims 18-20, drawn to a method for producing alkali-free glass sheets by a down draw process, classified in class 65, subclass 126.

The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as product and process of use. The inventions can be shown to be distinct if either or both of the following can be shown: (1) the process for using the product as claimed can be practiced with another materially different product or (2) the product as claimed can be used in a materially different process of using that product. See MPEP § 806.05(h). In the instant case the glass composition could be used for a non-sheet making process, such as a batch process or a lens pressing process. Furthermore, if a plate of the material were made, it could also be produced in a materially different process, such as a process, which uses a forming process. Invention I could be used in any of the above mentioned processes to create a variety of glass products

2. Restriction for examination purposes as indicated is proper because all these inventions listed in this action are independent or distinct for the reasons given above

and there would be a serious search and examination burden if restriction were not required because one or more of the following reasons apply:

(a) the inventions have acquired a separate status in the art in view of their different classification;

(b) the inventions have acquired a separate status in the art due to their recognized divergent subject matter;

(c) the inventions require a different field of search (for example, searching different classes/subclasses or electronic resources, or employing different search queries);

(d) the prior art applicable to one invention would not likely be applicable to another invention;

(e) the inventions are likely to raise different non-prior art issues under 35 U.S.C. 101 and/or 35 U.S.C. 112, first paragraph.

Applicant is advised that the reply to this requirement to be complete must include (i) an election of a invention to be examined even though the requirement may be traversed (37 CFR 1.143) **and (ii) identification of the claims encompassing the elected invention**.

The election of an invention may be made with or without traverse. To reserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement

will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable on the elected invention.

If claims are added after the election, applicant must indicate which of these claims are readable upon the elected invention.

Should applicant traverse on the ground that the inventions are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the inventions to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other invention.

3. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Rejoining Practice

4. The examiner has required restriction between product and process claims. Where applicant elects claims directed to the product, and the product claims are subsequently found allowable, withdrawn process claims that depend from or otherwise require all the limitations of the allowable product claim will be considered for rejoinder.

All claims directed to a nonelected process invention must require all the limitations of an allowable product claim for that process invention to be rejoined.

In the event of rejoinder, the requirement for restriction between the product claims and the rejoined process claims will be withdrawn, and the rejoined process claims will be fully examined for patentability in accordance with 37 CFR 1.104. Thus, to be allowable, the rejoined claims must meet all criteria for patentability including the requirements of 35 U.S.C. 101, 102, 103 and 112. Until all claims to the elected product are found allowable, an otherwise proper restriction requirement between product claims and process claims may be maintained. Withdrawn process claims that are not commensurate in scope with an allowable product claim will not be rejoined. See MPEP § 821.04(b). Additionally, in order to retain the right to rejoinder in accordance with the above policy, applicant is advised that the process claims should be amended during prosecution to require the limitations of the product claims. **Failure to do so may result in a loss of the right to rejoinder**. Further, note that the prohibition against double patenting rejections of 35 U.S.C. 121 does not apply where the restriction requirement is withdrawn by the examiner before the patent issues. See MPEP § 804.01.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew E. Hoban whose telephone number is (571) 270-3585. The examiner can normally be reached on Monday - Friday from 7:30 AM to 5 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vickie Kim can be reached on (571) 272-0579. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

meh

/Vickie Kim/
Supervisory Patent Examiner, Art Unit 4116

OIPE IAP22
FEB 04 2008
PATENT & TRADEMARK OFFICE

ATTORNEY DOCKET NO.: ADP-231 (SP05-073)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor:	Adam J. Ellison	
Serial No:	11/478493	Art Group Unit: 4116
Filing Date:	June 28, 2006	Examiner: Matthew E. Hoban
Title:	FINING OF BOROALUMINO SILICATE GLASSES	**RESPONSE**

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO EXAMINER'S RESTRICTION REQUIREMENT

In the Office Action dated January 23, 2008, designated as Paper No. 20080110 in the above-captioned application, the Examiner issued a Restriction Requirement identifying the following groups of claims as being drawn to potentially distinct inventions:

Group I. Claims 1-17, drawn to a composition of alkali-free glass, classified in class 501, subclass 70; and

Group II. Claims 18-20, drawn to a method for producing alkali-free glass sheets by a down draw process, classified in class 65, subclass 126.

Applicant hereby elects Group I, claims 1-17 without traverse.

1. (Original) An alkali-free glass comprising in mole percent on an oxide basis:

SiO_2:	64.0-71.0
Al_2O_3:	9.0-12.0
B_2O_3:	7.0-12.0
MgO:	1.0-3.0
CaO:	6.0-11.5
SrO:	0-2.0
BaO:	0-0.1

wherein:

(a) $1.00 \leq \Sigma[RO]/[Al_2O_3] \leq 1.25$,

where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO; and

(b) the glass has at least one of the following compositional characteristics:

(i) on an oxide basis, the glass comprises at most 0.05 mole percent Sb_2O_3;

(ii) on an oxide basis, the glass comprises at least 0.01 mole percent SnO_2.

2. (Original) The glass of Claim 1 wherein the glass has both compositional characteristics (i) and (ii).

3. (Original) The glass of Claim 1 wherein:

(a) the glass has compositional characteristic (i); and

(b) the glass has the further compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3.

4. (Original) The glass of Claim 1 wherein:

(a) the glass has compositional characteristic (ii); and

(b) the glass has the further compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3.

5. (Original) The glass of Claim 1 wherein:

(a) the glass has both compositional characteristics (i) and (ii); and

(b) the glass has the further compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3.

6. (Original) The glass of Claim 1 wherein on an oxide basis, SrO is at most 1.0 mole percent.

7. (Original) The glass of Claim 1 wherein the glass has a density that is less than or equal to 2.41 grams/cm^3.

8. (Original) The glass of Claim 1 wherein the glass has one or more of the following properties:

(a) a liquidus viscosity that is greater than or equal to 100,000 poise;

(b) a strain point that is greater than or equal to 650°C;

(c) a linear coefficient of thermal expansion (CTE) over the temperature range 0-300 °C which satisfies the relationship:

$$28 \times 10^{-7}/°C \leq CTE \leq 34 \times 10^{-7}/°C.$$

9. (Original) An alkali-free glass comprising in mole percent on an oxide basis:

SiO_2:	64.0-71.0
Al_2O_3:	9.0-12.0
B_2O_3:	7.0-12.0
MgO:	1.0-3.0
CaO:	6.0-11.5
SrO:	0-1.0
BaO:	0-0.1

wherein:

$\Sigma[RO]/[Al_2O_3] \geq 1.00$,

where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO.

10. (Original) The glass of Claim 9 wherein:

$$\Sigma[RO]/[Al_2O_3] \leq 1.25.$$

11. (Original) The glass of Claim 9 wherein the glass has a density that is less than or equal to 2.41 grams/cm^3.

12. (Original) The glass of Claim 9 wherein the glass has one or more of the following properties:

(a) a liquidus viscosity that is greater than or equal to 100,000 poise;

(b) a strain point that is greater than or equal to 650°C;

(c) a linear coefficient of thermal expansion (CTE) over the temperature range 0-300 °C which satisfies the relationship:

$$28 \times 10^{-7}/°C \leq CTE \leq 34 \times 10^{-7}/°C.$$

13. (Original) The glass of Claim 9 wherein the glass has at least one of the following compositional characteristics:

(a) on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3;

(b) on an oxide basis, the glass comprises at most 0.05 mole percent Sb_2O_3;

(c) on an oxide basis, the glass comprises at least 0.01 mole percent SnO_2.

14. (Original) The glass of Claim 13 wherein the glass has compositional characteristics (a) and (b).

15. (Original) The glass of Claim 13 wherein the glass has compositional characteristics (a) and (c).

16. (Original) The glass of Claim 13 wherein the glass has compositional characteristics (b) and (c).

17. (Original) The glass of Claim 13 wherein the glass has compositional characteristics (a), (b), and (c).

18. (Withdrawn) A method for producing alkali-free glass sheets by a downdraw process comprising selecting, melting, and fining batch materials so that the glass making up the sheets comprises SiO_2, Al_2O_3, B_2O_3, MgO, and CaO, and, on an oxide basis, has:

(i) a $\Sigma[RO]/[Al_2O_3]$ ratio greater than or equal to 1.0, where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ is the sum of the mole percents of MgO, CaO, SrO, and BaO; and

(ii) a MgO content greater than or equal to 1.0 mole percent;

wherein:

(a) the fining is performed without the use of substantial amounts of either arsenic or antimony; and

(b) a population of 50 sequential glass sheets produced by the downdraw process from the melted and fined batch materials has an average gaseous inclusion level of less than 0.05 gaseous inclusions/cubic centimeter, where each sheet in the population has a volume of at least 500 cubic centimeters.

19. (Withdrawn) The method of Claim 18 wherein SnO_2 is used in the fining.

20. (Withdrawn) The method of Claim 18 wherein the glass making up the sheets is substantially free of BaO.

Claims 1-17 remain in this application. Claims 18-20 have been withdrawn as a result of the restriction requirement. In view of the examiner's restriction requirement, Applicant retains the right to present claims 18-20 in a divisional application, or alternatively, rejoinder of claims as appropriate.

Applicants believe that no extension of time is necessary to make this Response timely. Should Applicants be in error, Applicants respectfully request the Office grant such time extension pursuant to 37 C.F.R. § 1.136(a) as necessary to make this Response timely, and hereby authorizes the Office to charge any necessary fee or surcharge with respect to said time extension to the deposit account of the undersigned firm of attorneys, Deposit Account 03-3325.

Please direct any questions or comments to Thomas R. Beall at (607) 974-3921.

Respectfully submitted,

Date: January 30, 2008

Thomas R. Beall
Registration No. 40,424
Corning Incorporated
Patent Department
Mail Stop SP-TI-03-1
Corning, NY 14831

CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8: I hereby certify that this paper and any papers referred to herein are being deposited with the U.S. Postal Service, as first class mail, postage prepaid, addressed to Mail Stop Amendment, Commissioner for Patents, Alexandria, VA 22313-1450 on January 30, 2008.

Thomas R. Beall

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☒ To be Mailed
11/478,493	06/28/2006	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 02/04/2008	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $ =		OR	X $50=	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $ =		OR	X $210=	0
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

AMENDMENT	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/NICHELE PETERSON/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)	5778

22928 7590 04/01/2008
CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

EXAMINER	
HOBAN, MATTHEW E	
ART UNIT	PAPER NUMBER
1793	
MAIL DATE	DELIVERY MODE
04/01/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	11/478,493	ELLISON, ADAM J.G.	
	Examiner	Art Unit	
	Matthew E. Hoban	1793	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04 February 2008*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-17* is/are pending in the application.

4a) Of the above claim(s) *18-20* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-17* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *6/28/2006, 6/28/2006 and 10/10/2006*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

3. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 1-17 rejected under 35 U.S.C. 103(a) as being unpatentable over Dumbaugh in 5374595 in view of Narita in 6,468,933.

The instant claims are directed to an alkali free glass with the following compositional characteristics:

Based on mole percent on an oxide basis the glass is comprised of:

SIO2: 64.0-71.0
A1203: 9.0-12.0
B203: 7.0-12.0
MgO: 1.0-3.0
CaO: 6.0-11.5
SrO: 0-2.0
BaO: 0-0.1

Furthermore, the ratio between divalent oxides and aluminum is between 1 and 1.25.

Several claims are also directed towards fining agents added to the composition. There are three different fining characteristics:

a) <.05 mol% antimony oxide

b) <.01 mol% tin oxide

c) <.05% arsenic oxide

One or more of these characteristics apply depending on the instant claim.

The glass also has distinct properties, where it has a density less than or equal to 2.41 grams/cc and can also have one or more of the following properties:

(a) a liquidus viscosity that is greater than or equal to 100,000 poise;
(b) a strain point that is greater than or equal to 650°C;

(c) a linear coefficient of thermal expansion (CTE) over the temperature

range 0-300 °C which satisfies the relationship:

28 x 10-7/°C < CTE < 34 x 10-7/°C.

The claims are structured such that Claim 1 and 9 each include limitations regarding the composition, the ratio between RO and alumina, and the fining agents included in the composition. For the sake of brevity and transparency, these three different sets of limitations will be addressed individually below

Regarding Claims 1, 6 and 9 (COMPOSITION): These claims include language directed towards the major oxide components of the glass.

Dumbaugh et al teach a similar glass for use as a substrate in flat panel display devices, where his composition has overlapping ranges with the composition of the instant claims 1, 6, and 9. These ranges can be found in column 4 of their patent.

Dumbaugh et al. fail to teach any examples or compositional ranges that are sufficiently specific to anticipate the compositional limitations of claims 1, 6, and 9. However, overlapping ranges have been held to establish prima facie obviousness. See MPEP 2144.05.

Accordingly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have selected from the overlapping portion of the ranges disclosed by the reference because overlapping ranges have been held to establish prima facie obviousness. See MPEP 2144.05.

Claim 6 of the instant claims serves to further adjust the SrO level in the glass to below 1 mol%; however, Dumbaugh's range of SrO is inclusive of 0 mol% and he teaches that SrO is a CTE adjusting oxide. Thus adjusting this oxide would only have predictable results on the final glass composition.

Regarding Claims 1, 9, 10 (RO/AL2O3 ratio): These claims include language regarding the ratio of the sum of divalent metal oxides to aluminum oxide. These claims specify that the ratio between these two must be between 1 and 1.25.

As stated previously, Dumbaugh teaches overlapping ranges that create a prima facie case of obvious. Although his compositions may not be sufficiently specific to anticipate the compositional limitations of claims 1, 6 and 9, it is still possible to determine the ratio between divalent metal oxides and aluminum in his specific embodiments. The examiner analyzed the ratio between these two components and found that approximately 41 of Dumbaugh's 51 specific embodiments (taught in Table IIa) exhibited ratios between 1 and 1.25. Furthermore, Dumbaugh teaches a further limitation in his ranges found in column 4, where the summation of divalent metal oxides must be between 10 and 20 mol%. From this recitation, one of ordinary skill would

delve that not only are the individual amounts of these oxides important, but also their summation. Based on these two facts, it would be considered obvious to one of ordinary skill in the art at the time the invention was made to have not only selected from the overlapping portion of the ranges as disclosed, but to also remain within the spirit of Dumbaugh's invention by maintaining the amount of divalent metal oxides relative to aluminum oxide.

Regarding Claims 1-5, 9, 13-17 (FINING AGENTS): These claims include language regarding the fining agent added to the glass composition (or have dependant claims associated to them regarding this aspect)

The composition of Dumbaugh teaches the use of conventional fining agents such as arsenic oxide (See Column 6, first full paragraph). Dumbaugh thus does not disclose or make obvious the use of Tin oxide as a fining agent.

However, Narita does disclose the use of tin oxide as a replacement fining agent for arsenic oxide. In the background of his invention (Section (2) Prior Art in Column 1) Narita explains that alkali free glasses, such as the one that is the subject of his teachings, as well as those of Dumbaugh, are typically used as a glass substrate for a liquid crystal display. An important aspect of these glasses is the creation of a glass without bubbles. This is done by adding fining agents, which generate a fining gas in the melt. This melting process is usually at a high temperature, due to the lack of alkali-oxides, so the selection of a fining agent is dependant on this fact. Previously, arsenic oxide was used as a fining agent, but as is commonly known and

also taught by Narita, arsenic oxide is very toxic and causes pollution. To solve this issue, Narita uses a Tin Oxide and Chloride instead of arsenic oxide (See Column 1, Lines 54-58). As can be seen in his examples as well as in Tables 2-5, tin oxide and chloride are added in an amount of .05-2 wt% and .005-1 wt% respectively. These figures in the context of Narita's specific examples generally translate to .025-1 mol% and .005-1 mol%, respectively. For example, composition 9 in Table 5 contains .9 wt% or .42 mol% tin oxide. As stated, Narita's compositions are substantially arsenic free, meaning they have less than .02 mol% Arsenic is present (See Column 3, Lines 56-60). Narita is silent as to the amount of antimony in the composition, but because tin oxide and chloride are the only fining agents, one of ordinary skill in the art would find it obvious that the amount of antimony would also be less than .05 mol%.

The fining agent of Narita, Tin Oxide and Chloride, could be directly incorporated into the composition of Dumbaugh. Dumbaugh states that a possible fining agent in his composition is arsenic oxide, where Narita teaches his fining agents as a replacement for arsenic oxide. When combining these two references, only tin oxide and chloride would be used for fining in the same wt% as the teachings of Narita, whose teachings teach an amount of tin oxide greater than .01 mole percent, with no antimony oxide or arsenic oxide. This combination of fining agents makes obvious all fining characteristics found in claims 1-5 and 13-17.

The combination of these teachings would produce less toxic gas during manufacturing, which would have been obvious motivation for one of ordinary skill in the art at the time the invention was made. Furthermore, these two fining agents (arsenic and tin oxide) according to Narita

perform entirely the same function, meaning that they are generally interchangeable and create no unexpected results.

Regarding Claims 7 and 11: These claims are directed towards the density of the glass, which must be less than 2.41 g/cc

Dumbaugh, as well as the combination of references Dumbaugh in view of Narita, fail to disclose the density found in instant claims 7 and 11. However, the composition of Dumbaugh in view of Narita has overlapping ranges of components with the claimed glass; therefore, one of ordinary skill in the art would expect that the glass of Dumbaugh in view of Narita would have this claimed property.

Therefore , it would have been obvious to one of ordinary skill in the art at the time the invention was made to have a glass with the compositional characteristics as recited in claims 1 or 9 and a density less than 2.41 g/cc

Regarding Claims 8 and 12: These claims are directed towards properties of the glass, where only one property must be present selected among a liquidus viscosity greater than 100,000 poise, a strain point greater than 650 C, and a linear coefficient of thermal expansion of between 28-34e-7

Dumbaugh teaches that the range of oxides of his glass, which can be seen in the table in column 4 have distinct properties including a CTE of between 32e-7 and 46e-7, a strain point higher than 650 C, a liquidus temperature no higher than 1200, and a liquidus viscosity greater than 200,000 poise (See Column 4, Lines 19-32).

In view of these properties, it is clear that the liquidus viscosity of the glasses of Dumbaugh meets the limitations of the instant claims. The addition of an interchangeable fining agent in place of arsenic oxide would not affect the liquidus viscosity to a substantial degree.

Furthermore, the range of CTE for Dumbaugh's range of glasses encompasses that of the instant claims. Dumbaugh specifically teaches that the thermal expansion of his glasses is affected by the amount of SrO, BaO, MgO, and CaO, where SrO and BaO have a more pronounced effect on this property. It would be well within the skill of one of ordinary skill in the art to optimize the CTE by altering the amounts of these components within the range designated by Dumbaugh. Therefore, the range of CTE's as claimed are obvious in light of Dumbaugh in view of Narita.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew E. Hoban whose telephone number is (571) 270-3585. The examiner can normally be reached on Monday - Friday from 7:30 AM to 5 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jerry Lorengo can be reached on (571) 272-1233. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Jerry A Lorengo/
Supervisory Patent Examiner, Art Unit 1793

meh

Notice of References Cited	Application/Control No. 11/478,493	Applicant(s)/Patent Under Reexamination ELLISON, ADAM J.G.	
	Examiner Matthew E. Hoban	Art Unit 1793	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,468,933	10-2002	Narita et al.	501/56
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11478493	ELLISON, ADAM J.G.
	Examiner	Art Unit
	Matthew E Hoban	1793

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	03/20/2008								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
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	16	✓								
	17	✓								
	18	÷								
	19	÷								
	20	÷								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11478493	ELLISON, ADAM J.G.
	Examiner	**Art Unit**
	Matthew E Hoban	1793

SEARCHED

Class	Subclass	Date	Examiner
501	+text	3/20/2008	meh

SEARCH NOTES

Search Notes	Date	Examiner
See East Search History	3/20/2008	meh
Inventor Search Completed through PALM	3/20/2008	meh

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Adam J.G. Ellison	Examiner: TBA	
Serial No:		Group Art Unit: TBA	
Filed:			
For:	FINING OF BOROALUMINO SILICATE GLASSES		

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. §§ 1.56, 1.97 – 1.98

Mail Stop Amendment
Commissioner of Patents
Alexandria, VA 22313-1450

Dear Sir:

The Examiner's attention is hereby directed to the following reference(s) listed on the attached Form PTO-1449 for consideration in connection with the examination of the above-identified patent application. [One copy of any non-US patent is enclosed.]

This submission does not represent that a search has been made or that no better art exists and does not constitute an admission that each or all of the enclosed documents constitute "prior art." If it should be determined that any of the submitted documents do not constitute "prior art" under United States law, applicant(s) reserve the right to present to the office the relevant facts and law regarding the appropriate status of such documents.

Applicant(s) further reserve the right to take appropriate action to establish the patentability of the disclosed invention over the enclosed references, should one or more of the references be applied against the claims of the present application.

Respectfully submitted,

Thomas R. Beall
Registration No. 40,424
Corning Incorporated
SP-TI-03-1
Corning, NY 14831
607-974-3921
Date: June 28, 2006

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to Mail Stop Amendment, Commissioner of Patents, P.O. Box 1450, Alexandria, Va 22313-1450 on June 28, 2006.
Date of Deposit

Thomas R. Beall
Name of applicant, assignee, or Registered Representative

Signature

June 28, 2006
Date of Signature

FORM PTO-1449 (MODIFIED) LIST OF PATENTS AND PUBLICATIONS FOR APPLICANTS INFORMATION DISCLOSURE STATEMENT	ATTORNEY DOCKET NO. ADP-231 (SP05-073)	SERIAL NO.
	APPLICANT Adam J.G. Ellison	
	FILING DATE	GROUP: TBA

REFERENCE DESIGNATION — U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Sub-Class	Filing Date if Approp.
/M.H./	AA	3,338,696	08-29-67	Stuart M. Dockerty	65	145	
	AB	3,682,609	08-08-72	Stuart M. Dockerty	65	83	
	AC	5,374,595	12-20-94	W.H. Dumbaugh et al.	501	66	
	AD	5,785,726	07-28-98	W.G. Dorfeld et al.	65	134.1	
	AE	5,824,127	10-20-98	James C. Bange et al.	65	90	
	AF	6,128,924	10-10-00	James C. Bange et al.	65	90	
/M.H./	AG	6,319,867	11-20-01	Lisa C. Chacon et al.	501	66	
	AH						
	AI						
	AJ						
	AK						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Sub-Class	Translation Yes	Translation No
/M.H./	AL	RU642265	01-15-79	Russia			X	
	AM							
	AN							
	AO							
	AP							
	AQ							

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)

	AR	
	AS	
	AT	
	AU	
	AV	
	AW	

EXAMINER: /Matthew Hoban/ DATE CONSIDERED: 03/20/2008

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609: draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

OIPE IAP98 OCT 10 2006 PATENT & TRADEMARK OFFICE

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Adam J.G. Ellison, et al	
Serial No:	11/478493	Examiner: TBA
Filed:	June 28, 2006	Group Art Unit: 1756
For:	FINING OF BOROALUMINO SILICATE GLASSES	

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. §§ 1.56, 1.97 – 1.98

Mail Stop Amendment
Commissioner of Patents
Alexandria, VA 22313-1450

Dear Sir:

The Examiner's attention is hereby directed to the following reference(s) listed on the attached Form PTO-1449 for consideration in connection with the examination of the above-identified patent application. One copy of any non-US patent is enclosed.

Each of the enclosed reference(s) was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement.

This submission does not represent that a search has been made or that no better art exists and does not constitute an admission that each or all of the enclosed documents constitute "prior art." If it should be determined that any of the submitted documents do not constitute "prior art" under United States law, applicant(s) reserve the right to present to the office the relevant facts and law regarding the appropriate status of such documents.

Applicant(s) further reserve the right to take appropriate action to establish the patentability of the disclosed invention over the enclosed references, should one or more of the references be applied against the claims of the present application.

Respectfully submitted,

Thomas R. Beall
Registration No. 40,425
Corning Incorporated
SP-TI-03-1
Corning, NY 14831
607-974-3921
Date: September 28, 2006

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to Mail Stop Amendment, Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on September 28, 2006.
Date of Deposit

Thomas R. Beall
Name of applicant, assignee, or Registered Representative

Signature

September 28, 2006
Date of Signature

Revision: September 1, 2002
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O.I.P.E. 1450 OCT 10 2006 PATENT & TRADEMARK OFFICE

FORM PTO-1449 (MODIFIED) LIST OF PATENTS AND PUBLICATIONS FOR APPLICANTS INFORMATION DISCLOSURE STATEMENT	ATTORNEY DOCKET NO. ADP-231 (SP05-073)	SERIAL NO. 11/478493
	APPLICANT Adam J.G. Ellison, et al.	
	FILING DATE June 28, 2006	GROUP: 1756

REFERENCE DESIGNATION U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Sub-Class	Filing Date if Approp.
/M.H./	AA	2003/0121288	07-03-03	Jun Naka et al.	65	134.3	
	AB						
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	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Sub-Class	Translation Yes	Translation No
/M.H./	AL	EP 0 607 865	07-27-94	Europe			X	
	AM							
	AN							
	AO							
	AP							
	AQ							

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)

	AR	
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	AU	
	AV	
	AW	

EXAMINER: /Matthew Hoban/ DATE CONSIDERED: 03/20/2008

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609: draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	52	"5785726" "6128924" "5824127"	US-PGPUB; USPAT	OR	ON	2008/01/10 11:46
S2	0	("2004/0209758").URPN.	USPAT	OR	ON	2008/01/10 11:47
S3	76	US-20070096631-$.DID. OR US-20070170856-$.DID. OR US-20070170455-$.DID. OR US-20070170859-$.DID. OR US-20070170850-$.DID. OR US-20070170845-$.DID. OR US-20070090759-$.DID. OR US-20070170855-$.DID. OR US-20070170849-$.DID. OR US-20070170846-$.DID. OR US-20070173167-$.DID. OR US-20070114909-$.DID. OR US-20070170861-$.DID. OR US-20070170423-$.DID. OR US-20070170605-$.DID. OR US-20070170839-$.DID. OR US-20070170324-$.DID. OR US-20070170860-$.DID. OR US-3414465-$.DID. OR US-4330596-$.DID. OR US-3973975-$.DID. OR US-3995941-$.DID. OR US-20040069017-$.DID. OR US-6733850-$.DID. OR US-6734615-$.DID. OR US-20010015620-$.DID. OR US-20010033135-$.DID. OR US-20010045565-$.DID. OR US-20010048234-$.DID. OR US-20010049197-$.DID. OR US-20010053082-$.DID. OR US-20010055841-$.DID. OR US-20020004577-$.DID. OR US-20020008463-$.DID. OR US-20020015032-$.DID. OR	US-PGPUB; USPAT	OR	ON	2008/01/10 16:47

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S6	11	naka.in. and jun.in.	USPAT	OR	OFF	2008/03/20 08:29

S7	20	"5824127"	USPAT	OR	OFF	2008/03/20 08:37
S8	33	("501".clas.) and (alkali-free or alkali adj free).ti.	USPAT	OR	OFF	2008/03/20 08:39
S9	36	("501".clas.) and (alkali-free or alkali adj free).ti.	USPAT; USOCR	OR	OFF	2008/03/20 08:47
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S12	1	11/116669.app.	US-PGPUB; USPAT	OR	OFF	2008/03/20 09:58

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PATENT
Attorney Docket No.: ADP-231 (SP05-073)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Adam J.G. Ellison	Examiner: TBA	
Serial No:		Group Art Unit: TBA	
Filed:			
For:	FINING OF BOROALUMINO SILICATE GLASSES		

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In addition to the prior art of record in this application, including the publications specifically mentioned in the application and/or listed in one or more forms PTO-1449 being submitted in this case, the Examiner's attention is also invited to the following non-art document(s) consisting of one or more co-pending U. S. patent applications assigned to the assignee of the present application:

Serial No.	Applicant(s)	Filing Date
11/116,669	DeAngelis et al.	04/27/2005

While the claims of the above-listed application(s) generally relate to the ceramic arts, it is the position of the Applicant(s) that the claims of the present application cover only subject matter that is patentably distinct therefrom.

Respectfully submitted,

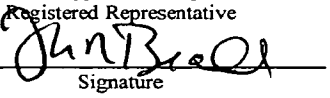


Thomas R. Beall
Registration No. 40,424
Corning Incorporated
SP-TI-03-1
Corning, NY 14831
607-974-3921

Date: June 28, 2006

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Va 22313-1450 on June 28, 2006
Date of Deposit

Thomas R. Beall
Name of applicant, assignee, or Registered Representative



Signature

June 28, 2006
Date of Signature

FORM PTO-1449 (MODIFIED) LIST OF PATENTS AND PUBLICATIONS FOR APPLICANTS INFORMATION DISCLOSURE STATEMENT	ATTORNEY DOCKET NO. ADP-231 (SP05-073)	SERIAL NO.
	APPLICANT Adam J.G. Ellison	
	FILING DATE	GROUP: TBA

REFERENCE DESIGNATION — U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Sub-Class	Filing Date if Approp.
/M.H./	AA	11/116,669		G. DeAngelis et al.			04/27/05
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	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Sub-Class	Translation Yes	No
	AL							
	AM							
	AN							
	AO							
	AP							
	AQ							

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)

	AR	
	AS	
	AT	
	AU	
	AV	
	AW	

EXAMINER: /Matthew Hoban/ DATE CONSIDERED: 03/28/2008

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609: draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[298] Attorney Docket No. : ADP-231 US



PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

AMENDMENT

This Amendment is submitted in response to the Office Action dated April 1, 2008. Its contents are:

(1) a listing of the claims of the application which includes the amendments to the claims being made by this Amendment -- page 2; and

(2) applicant's Remarks -- page 7.

Submitted herewith is a petition under 37 CFR §1.136 and the required fee requesting a one month extension in which to file this Amendment. With the extension, this response is due on August 1, 2008. No further extension of time is believed to be necessary for the filing of this Amendment, but if such an extension of time is required, applicant requests that this be considered a petition therefor. The Director is hereby authorized to charge any fees which may be required for such an extension to Deposit Account No. 11-1158.

Amendments to the Claims:

This listing of claims will replace all prior versions of the claims in this application:

Listing of Claims:

Claim 1 (currently amended) An alkali-free glass comprising in mole percent on an oxide basis:

SiO_2:	64.0-71.0
Al_2O_3:	9.0-12.0
B_2O_3:	7.0-12.0
MgO:	1.0-3.0
CaO:	6.0-11.5
SrO:	0-2.0
BaO:	0-0.1

wherein:

(a) $1.00 \leq \Sigma[RO]/[Al_2O_3] \leq 1.25$,

where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO; and

(b) the glass has ~~at least one of~~ the ~~following~~ compositional characteristic that ~~characteristics:~~

~~(i) on an oxide basis, the glass comprises at most 0.05 mole percent Sb_2O_3;~~

~~(ii)~~ on an oxide basis, the glass comprises at least 0.01 mole percent SnO_2.

Claim 2 (currently amended) The glass of Claim 1 wherein the glass has ~~both~~ the additional compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent Sb_2O_3. ~~characteristics (i) and (ii).~~

Claim 3 (canceled)

Claim 4 (currently amended) The glass of Claim 1 wherein [[:]]

~~(a) the glass has compositional characteristic (ii); and~~

~~(b)~~ the glass has the further compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3.

Claim 5 (currently amended) The glass of Claim 2 [[1]] wherein [[:]]

~~(a) the glass has both compositional characteristics (i) and (ii); and~~

~~(b)~~ the glass has the further compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3.

Claim 6 (original) The glass of Claim 1 wherein on an oxide basis, SrO is at most 1.0 mole percent.

Claim 7 (original) The glass of Claim 1 wherein the glass has a density that is less than or equal to 2.41 grams/cm^3.

Claim 8 (original) The glass of Claim 1 wherein the glass has one or more of the following properties:

(a) a liquidus viscosity that is greater than or equal to 100,000 poise;

(b) a strain point that is greater than or equal to 650°C;

(c) a linear coefficient of thermal expansion (CTE) over the temperature range 0-300 °C which satisfies the relationship:

$$28 \times 10^{-7}/°C \leq CTE \leq 34 \times 10^{-7}/°C.$$

Claim 9 (original) An alkali-free glass comprising in mole percent on an oxide basis:

SiO_2:	64.0-71.0
Al_2O_3:	9.0-12.0
B_2O_3:	7.0-12.0
MgO:	1.0-3.0
CaO:	6.0-11.5
SrO:	0-1.0
BaO:	0-0.1

wherein:

$\Sigma[RO]/[Al_2O_3] \geq 1.00$,

where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO.

Claim 10 (original) The glass of Claim 9 wherein:

$\Sigma[RO]/[Al_2O_3] \leq 1.25$.

Claim 11 (original) The glass of Claim 9 wherein the glass has a density that is less than or equal to 2.41 grams/cm^3.

Claim 12 (original) The glass of Claim 9 wherein the glass has one or more of the following properties:

(a) a liquidus viscosity that is greater than or equal to 100,000 poise;

(b) a strain point that is greater than or equal to 650°C;

(c) a linear coefficient of thermal expansion (CTE) over the temperature range 0-300 °C which satisfies the relationship:

$$28 \times 10^{-7}/°C \leq CTE \leq 34 \times 10^{-7}/°C.$$

Claim 13 (original) The glass of Claim 9 wherein the glass has at least one of the following compositional characteristics:

(a) on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3;

(b) on an oxide basis, the glass comprises at most 0.05 mole percent Sb_2O_3;

(c) on an oxide basis, the glass comprises at least 0.01 mole percent SnO_2.

Claim 14 (original) The glass of Claim 13 wherein the glass has compositional characteristics (a) and (b).

Claim 15 (original) The glass of Claim 13 wherein the glass has compositional characteristics (a) and (c).

Claim 16 (original) The glass of Claim 13 wherein the glass has compositional characteristics (b) and (c).

Claim 17 (original) The glass of Claim 13 wherein the glass has compositional characteristics (a), (b), and (c).

Claim 18 (withdrawn) A method for producing alkali-free glass sheets by a downdraw process comprising selecting, melting, and fining batch materials so that the glass making up the sheets comprises SiO_2, Al_2O_3, B_2O_3, MgO, and CaO, and, on an oxide basis, has:

(i) a $\Sigma[RO]/[Al_2O_3]$ ratio greater than or equal to 1.0, where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ is the sum of the mole percents of MgO, CaO, SrO, and BaO; and

(ii) a MgO content greater than or equal to 1.0 mole percent;

wherein:

(a) the fining is performed without the use of substantial amounts of either arsenic or antimony; and

(b) a population of 50 sequential glass sheets produced by the downdraw process from the melted and fined batch materials has an average gaseous inclusion level of less than 0.05 gaseous inclusions/cubic centimeter, where each sheet in the population has a volume of at least 500 cubic centimeters.

Claim 19 (withdrawn) The method of Claim 18 wherein SnO_2 is used in the fining.

Claim 20 (withdrawn) The method of Claim 18 wherein the glass making up the sheets is substantially free of BaO.

REMARKS

This is in response to the Office Action dated April 1, 2008.

In the Office Action, the Examiner rejected applicant's Claims 1-17 as allegedly unpatentable under 35 U.S.C. §103(a) based on Dumbaugh et al. U.S. Patent No. 5,374,595 in view of Narita et al., U.S. Patent No. 6,468,933. Applicant respectfully traverses this rejection.

As the predicate for the rejection the Examiner asserted that the compositional ranges of the present application overlap with the compositional ranges of the Dumbaugh patent:

> Dumbaugh et al teach a similar glass for use as a substrate in flat panel display devices, where his composition has overlapping ranges with the composition of the instant claims 1, 6, and 9. These ranges can be found in column 4 of their patent. (4/1/08 Office Action at page 4.)

The Examiner acknowledged that "Dumbaugh et al. fail to teach any examples or compositional ranges that are sufficiently specific to anticipate the compositional limitations of claims 1, 6, and 9." (Id.)

Applicant does not agree that overlapping ranges is a proper basis for an obviousness rejection. However, even if this were a proper basis, the Examiner has not established overlapping ranges between the claims of this application and the ranges disclosed in Dumbaugh.

As acknowledged by the Examiner on page 3 of the Office Action, the claims of this application require a BaO concentration in the 0-0.1 mole percent range. Dumbaugh, on the other hand, specifies a BaO concentration range of 2-7 mole percent. (Dumbaugh et al. at column 4, line 38.) Accordingly, the glasses of this invention are very different from those of Dumbaugh et al.

In addition to asserting overlapping compositional ranges, the Examiner made further assertions regarding others of the limitations of Claims 1, 6 and 9, as well as the limitations of the remainder of applicant's claims. Applicant does not agree with those assertions. However, given the fundamental distinction between applicant's claims and

the cited references detailed above, a discussion of the other limitations and their patentable significance is not believed necessary at this time.

Submitted herewith is an Information Disclosure Statement with further references which applicant wishes to make of record in this application. One of those references, i.e., Nishizawa et al., PCT Patent Publication WO 2004/087597 corresponding to U.S. Patent Publication No. US 2006/0003884, contains a comparative example whose composition, specifically, the example's B_2O_3 and SrO contents, lies on the periphery of the compositional ranges of applicant's original Claim 1. See the "Comp. Ex." of Table 1 on page 8 of the '884 publication.

Nishizawa et al. plainly consider this comparative example to be unacceptable. However, to ensure that Claim 1 avoids this reference, applicant has amended Claim 1 so that instead of being an optional limitation, the claim now requires a SnO_2 content of at least 0.01 mole percent. Nishizawa et al.'s comparative example does not include any tin. Moreover, this example cannot render applicant's claims obvious since Nishizawa et al. use this example to illustrate what in their view, should not be done, i.e., Nishizawa et al. teach away from glasses having the composition of their comparative example. The remainder of Nishizawa et al.'s many examples are fully outside the compositional ranges of applicant's claims

In view of the foregoing, applicant respectfully submits that this application is now in condition for allowance. Accordingly, reconsideration and the issuance of a Notice of Allowance for the application are respectfully requested.

Respectfully submitted,

Date: 8/1/08

Maurice Klee

Maurice M. Klee, Ph.D.
Reg. No. 30,399
Attorney for Applicant
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AUG 04 2008
PATENT & TRADEMARK OFFICE
IAP30

PTO/SB/22 (08-08)
Approved for use through 08/31/2008. OMB 0651-0031
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a) **FY 2008** *(Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).)*	Docket Number (Optional) ADP-231 US
Application Number 11/478,493	Filed June 28, 2006
For FINING OF BOROALUMINO SILICATE GLASSES	
Art Unit 1793	Examiner M. Hoban

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	
[X] One month (37 CFR 1.17(a)(1))	$120	$60	$ 120.00
[ ] Two months (37 CFR 1.17(a)(2))	$460	$230	$
[ ] Three months (37 CFR 1.17(a)(3))	$1050	$525	$
[ ] Four months (37 CFR 1.17(a)(4))	$1640	$820	$
[ ] Five months (37 CFR 1.17(a)(5))	$2230	$1115	$

[ ] Applicant claims small entity status. See 37 CFR 1.27.

[X] A check in the amount of the fee is enclosed.

[ ] Payment by credit card. Form PTO-2038 is attached.

[ ] The Director has already been authorized to charge fees in this application to a Deposit Account.

[X] The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 11-1158. I have enclosed a duplicate copy of this sheet.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

[ ] applicant/inventor.

[ ] assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed (Form PTO/SB/96).

[X] attorney or agent of record. Registration Number 30,399

[ ] attorney or agent under 37 CFR 1.34.
Registration number if acting under 37 CFR 1.34 _____

Maurice Klee
Signature

August 1, 2008
Date

Maurice M. Klee, Ph.D.
Typed or printed name

(269) 255-1400
Telephone Number

08/05/2008 ETECLE1 00000046 11478493
01 FC:1251 120.00 OP

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below.

[ ] Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/SB/22 (08-08)
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U.S. Patent and Trademark Office; U.S. DEPARMENT OF COMMERCE
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[X] A check in the amount of the fee is enclosed.

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[ ] applicant/inventor.

[ ] assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed (Form PTO/SB/96).

[X] attorney or agent of record. Registration Number 30,399

[ ] attorney or agent under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34 _____

Maurice Klee — Signature

August 1, 2008 — Date

Maurice M. Klee, Ph.D. — Typed or printed name

(203) 255-1400 — Telephone Number

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below.

[ ] Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

[298] Attorney Docket No. : ADP-231 US



PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Serial No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

In accordance with 37 CFR §1.56 and 37 CFR §1.97(c), applicant wishes to call the Examiner's attention to the references listed on the supplemental listing under 37 CFR §1.98(a)(1) submitted herewith.

Copies of the references listed thereon are submitted herewith, with the exception of the references which are U.S. patents and U.S. patent application publications (37 CFR §1.98(a)(2)(ii)).

Pursuant to 37 CFR §1.97(c) and 37 CFR §1.17(p), a check for $180.00 is enclosed. The Director is hereby authorized to charge any additional fees which may be required by this paper, or credit any overpayment, to Deposit Account No. 11-1158.

In addition to these references, applicant would also like to bring to the attention of the Examiner the following commercial glass that was sold by NHTechno Glass Corporation under the designation NA32 prior to the priority date of this application:

Component	Mol%
SiO_2	68.2
Al_2O_3	10.3
B_2O_3	9.8
MgO	3.2
CaO	7.0
SrO	1.1
BaO	0.01
As_2O_3	0.29

The Examiner is respectfully requested to initial a copy of the supplemental listing under 37 CFR §1.98(a)(1) and return it to applicant to indicate consideration of the references listed thereon in connection with the prosecution of this application.

Respectfully submitted,

Date: 8/1/08

Maurice Klee

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Fairfield, CT 06824
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[298] Attorney Docket No. : ADP-231 US PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Serial No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT BY APPLICLANT
(Listing Under 37 CFR §1.98(a)(1))

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name
_____	1.	4,180,618	12/1979	Alpha et al.
_____	2.	6,881,692	04/2005	Murata et al.
_____	3.	2006/0003884	01/2006	Nishizawa et al.

FOREIGN PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Country
_____	4.	2001-348247	12/2001	JP
		with attached English abstract and computer translation obtained from the Japanese Patent Office website		
_____	5.	2004-189535	07/2004	JP
		with attached English abstract and with attached English translation		
_____	6.	2004/087597*	10/2004	WO
		with English abstract		

08/05/2008 ETECLE1 00000046 11478493
02 FC:1806 180.00 OP

*Corresponds to US 2006/0003884 (Reference 3 above).

PATENT ABSTRACTS OF JAPAN

OIPE IAP30 AUG 04 2008 PATENT & TRADEMARK OFFICE

(11)Publication number : 2001-348247
(43)Date of publication of application : 18.12.2001

(51)Int.Cl. C03C 3/095

(21)Application number : 2000-163351
(22)Date of filing : 31.05.2000

(71)Applicant : ASAHI GLASS CO LTD
(72)Inventor : KOIKE AKIO
NISHIZAWA MANABU
KASE JUNICHIRO
NAKAO YASUMASA

(54) ALKALINE-FREE GLASS

(57)Abstract:
PROBLEM TO BE SOLVED: To provide alkaline-free glass having low density, high Young's modulus and low coefficient of expansion.
SOLUTION: The alkaline-free glass consists of, by mol%, 60 to 75 SiO2, 1 to 16 Al2O3, 1 to 20 B2O3, 0 to 10 MgO, 0 to 12 CaO, 0 to 10 SrO, 0 to 1.5 BaO and 0.05 to 5 Y2O3 and does not substantially contain alkali metal oxides.

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damages caused by the use of this translation.

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1]By mol % display of the following oxide basis, substantially 60 to 75% of SiO_2, 1 to 16% of aluminum$_2O_3$, 1 to 20% of B_2O_3, Alkali free glass which does not contain substantially an alkali metal oxide, 0 to 10% of MgO, 0 to 12% of CaO, 0 to 10% of SrO, 0 to 1.5% of BaO, 0.05 to 5% of Y_2O_3, ** and others.

[Claim 2]The alkali free glass according to claim 1 whose density is below 2.55 g/cm^3 and whose mean coefficient of linear expansion at 50-350 ** is below 34x10^{-7}/**.

[Claim 3]The alkali free glass according to claim 1 or 2 which contains substantially neither P_2O_5 nor PbO nor As_2O_3 nor Sb_2O_3.

[Claim 4]The alkali free glass according to claim 1, 2, or 3 which temperature from which T_L and viscosity serve as 10^4 poise in liquid phase temperature is made into T_4, and is T_L-T_4<=50 **.

[Translation done.]

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2.**** shows the word which can not be translated.
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the suitable alkali free glass for substrates, such as a flat display and a photo mask.
[0002]
[Description of the Prior Art]Conventionally, characteristic (1) - (4) shown in the glass substrate used for a display, a photo mask, etc., especially the glass substrate in which thin films, such as an oxide, are formed in the surface below was demanded.
(1) Don't contain an alkali metal oxide substantially. This is to prevent thin film characteristics from an alkaline metal being spread in said thin film from a glass substrate, and deteriorating.
(2) A strain point is high. The process in which this forms said thin film is a high temperature process.
It is for controlling contraction (heat contraction) of the glass substrate accompanying the heat modification and glazing structure stabilization of a glass substrate in this process.

[0003](3) Have sufficient chemicals endurance to the various medicine used for semiconductor formation. Especially Buffered fluoric acid (fluoric acid + ammonium fluoride; BHF) for etching of SiO_x or SiN_x, it is used for etching of the chloride used for etching of ITO (oxide of In and Sn), and a metal electrode -- be durable to acid (nitric acid, sulfuric acid, etc.) of other various kinds, and the alkali of resist removing liquid.
(4) A bubble, a stria, inclusions (intension foreign matter), a pit (hollow), a crack, etc. should not be in an inside and the surface.
[0004]
[Problem(s) to be Solved by the Invention]In recent years, above-mentioned (1) characteristic [which is shown below in addition to the characteristic of - (4)] (5) - (7) has come to be required.
(5) Density is low. This is because the weight saving of the display is called for.

(6) Young's modulus is large. This is for desiring sheet metal-ization of the glass substrate for the weight saving of said display, and controlling the increase in a deflection of the glass substrate by this sheet-metal-izing.
(7) A coefficient of thermal expansion is small. This is for enlarging rising-and-falling-temperature speed in the heat treatment process of a display, and raising the productivity of a display.

[0005]On the other hand in the Table 1 and 2 of JP,2000-44278,A, density 2.50-2.60g[/cm] ^{3}, The glass for a display (conventionally henceforth glass) which Young's modulus is in 74.1 - 78.9GPa, and has a coefficient of thermal expansion in the range of 34.1 - 41.4x10 $^{-7}$/** is indicated. However, said glass whose coefficient of thermal expansion is still smaller conventionally than glass is called for for the productivity drive of a display, etc. This invention aims at offer of the alkali free glass which solves the above technical problem.
[0006]
[Means for Solving the Problem]Substantially this invention by mol % display of the following oxide basis 60 to 75% of SiO_2, 1 to 16% of aluminum$_2O_3$, 1 to 20% of B_2O_3, Alkali free glass which does not contain substantially an alkali metal oxide, 0 to 10% of MgO, 0 to 12% of CaO, 0 to 10% of SrO, 0 to 1.5% of BaO, 0.05 to 5% of Y_2O_3, ** and others, is provided.

[0007]
[Embodiment of the Invention]As for the density d of the alkali free glass (glass of following this invention) of this invention, it is preferred that it is below 2.55g[/cm] ^{3}. In 2.55 g/cm^3 **, there is a possibility that the weight saving of a display may become difficult. Below 2.50 g/cm^3 is below 2.45 g/cm^3 especially preferably more preferably.
[0008]As for the mean coefficient of linear expansion alpha at 50-350 ** of the glass of this invention, it is preferred that it is below 34x10 $^{-7}$/**. There is a possibility that rising-and-falling-temperature speed in the heat treatment process of a display cannot be enlarged, at 34x10 $^{-7}$/more than **. Below 32x10 $^{-7}$/** is below 30x10 $^{-7}$/** especially preferably more preferably.
[0009]As for Young's modulus E of the glass of this invention, it is preferred that they are 72 or more GPa. In less than 72 GPa, there is a possibility that the deflection of the glass substrate by prudence of glass may become large. 74 or more GPa is 76 or more GPa especially preferably more preferably.
[0010]As for the specific Young's modulus (= E/d) of the glass of this invention, it is preferred that they are 27 or more MNm/kg. In less than 27 MNm/kg, there is a possibility that the deflection of said glass substrate may become large. 29 or more MNm/kg is 30 or more MNm/kg especially preferably more preferably.
[0011]As for the strain point of the glass of this invention, it is preferred that it is not less than 650 **. There is a possibility that said heat contraction may become large too much at less than 650 **. Not less than 665 ** not less than 660 ** is not less than 675 ** most preferably

especially preferably.

[0012]As for liquid-phase-temperature T_L of the glass of this invention, it is preferred that it is 1400 ** or less. There is a possibility of devitrifying at the time of glass Tsukuru, at more than 1400 **. 1370 ** or less 1350 ** or less is 1300 ** or less most preferably especially preferably.

[0013]As for "T_L-T_4" in which viscosity subtracted temperature T_4 used as 10^4 poise from T_L, it is preferred that it is 50 ** or less. At more than 50 **, the problem of devitrifying at the time of shaping arises, and there is a possibility that manufacture of glass may become difficult. 30 ** or less is 0 ** or less especially preferably more preferably.

[0014]Next, the BHF-proof nature of the glass of this invention is described. When it is immersed for 20 minutes at 25 ** into the liquid which mixed to 9:1 the ammonium fluoride solution whose mass percentage display density is 40% about the glass of this invention, and the fluoric acid solution in which the display density is 50% by the volume ratio, it is preferred that the surface does not become cloudy. It is preferred that the mass reduction per unit volume of the glass for which it asked from the volume of glass and mass change of the glass by said immersion is below 0.6 mg/cm^3.

[0015]Next, the acid resistance of the glass of this invention is described. When concentration immerses the glass of this invention at 90 ** for 20 hours into the hydrochloric acid aqueous solution which is 0.1 mol/l., it is preferred that nebula, discoloration, a crack, etc. do not arise on the surface. It is preferred that the mass reduction per unit volume of the glass for which it asked from the volume of glass and mass change of the glass by said immersion is below 0.6 mg/cm^3. It is below 0.2 mg/cm^3 more preferably.

[0016]Substantially the glass of this invention by the mol % display of the following oxide basis 64 to 74% of SiO_2, 5 to 14% of aluminum$_2O_3$, 5 to 12% of B_2O_3, 0 to 6% of MgO, 0 to 10% of CaO, 0 to 6% of SrO, and 0 to 1.5% of BaO, It is preferred to contain substantially neither the alkali metal oxide, 0.05 to 3% of Y_2O_3, ** and others, PbO nor P_2O_5 nor As_2O_3 nor Sb_2O_3.

[0017]Next, about the presentation of the glass of this invention, % [mol %] is only written and it is explained. SiO_2 has an effect which is network former and makes d small, or an effect which makes a strain point high, and is indispensable. At more than 75%, glass dissolution becomes difficult or T_L becomes high too much. It is 73% or less more preferably 74% or less. In less than 60%, alpha to which d becomes large and to which a strain point falls becomes large too much, or chemical durability falls. It is not less than 66% especially preferably not less than 64% more preferably not less than 62%.

[0018]aluminum$_2O_3$ has an effect which stabilizes glass, and gets a strain point or enlarges E, and is indispensable. The BHF-proof nature to which T_L becomes high too much at more than 16% falls, or acid resistance falls. It is 13% or less more preferably 14% or less. At less than 1%, said effect becomes small too much. It is not less than 5% especially preferably not less

than 3% more preferably.

[0019]B_2O_3 reduces T_L which makes d small, which makes BHF-proof nature high and which makes glass dissolution easy, or has an effect which makes alpha small, and is indispensable. At more than 20%, E to which a strain point falls becomes small too much, or acid resistance falls. It is 9% or less especially preferably 12% or less more preferably 16% or less. At less than 1%, said effect becomes small too much. It is not less than 5% especially preferably not less than 3% more preferably.

[0020]Although MgO is not indispensable, in order to make glass dissolution easy or to enlarge E, it may contain to 10%. There is a possibility that T_L becomes high too much at more than 10% and that BHF-proof nature may fall or acid resistance may fall. It is 6% or less more preferably 8% or less. As for the content, when it contains MgO, it is preferred that it is 1% or more.

[0021]Although CaO is not indispensable, in order to enlarge E which makes glass dissolution easy or to stabilize glass, it may contain to 12%. There is a possibility that T_L may become high too much at more than 12%, or alpha may become large too much. It is 6% or less especially preferably 8% or less more preferably 10% or less. As for the content, when it contains CaO, it is preferred that it is 1% or more.

[0022]Although SrO is not indispensable, in order to make glass dissolution easy or to stabilize glass, it may contain to 10%. There is a possibility that T_L becomes high too much at more than 10% and that d may become large too much or alpha may become large too much. It is 4% or less more preferably 6% or less. As for the content, when it contains SrO, it is preferred that it is 1% or more.

[0023]Although BaO is not indispensable, in order to control the phase separation of glass, or in order to reduce T_L, it may contain to 1.5%. d becomes large too much at more than 1.5%. It is 1% or less preferably. It is preferred not to contain BaO substantially to make d smaller.

[0024]As for sum total MgO+CaO+SrO+BaO of the content of MgO, CaO, SrO, and BaO, it is preferred that it is 5 to 15%. There is a possibility that d or alpha may become large too much at more than 15%. It is 11% or less more preferably 13% or less. In less than 5%, there is a possibility that the solubility of glass may fall or E may become small too much. It is not less than 7% more preferably not less than 6%.

[0025]Y_2O_3 has an effect which makes glass dissolution easy and enlarges E, and is indispensable. The BHF-proof nature to which T_L becomes high too much at more than 5% falls, or acid resistance falls. It is 2% or less more preferably 3% or less. At less than 0.05%, said effect becomes small too much. It is 0.5% or more more preferably 0.1% or more.

[0026]Although the glass of this invention consists of the above-mentioned ingredient substantially, other ingredients may be contained in the range which does not spoil the purpose of this invention. As for the sum total of the content of an ingredient besides the

above, it is preferred that it is 15% or less. It is 10% or less more preferably.

[0027]Next, an ingredient besides the above is described. In order to improve the solubility, the clarity, or the moldability of glass, Fe_2O_3, SO_3, F, Cl, SnO_2, and As_2O_3, Sb_2O_3, etc. may be contained to 5% in total. As_2O_3, Sb_2O_3, or PbO needs the management for an environmental measure etc., and it is preferred to contain neither from this viewpoint. P_2O_5 has a possibility of reducing the chemical durability of glass, and not containing is preferred.

[0028]In order to enlarge, E ZnO, TiO_2, ZrO_2, V_2O_5, Cr_2O_3, MnO, CoO, NiO, CuO, Ga_2O_3, GeO_2, Nb_2O_5, MoO_3, CeO_2, Pr_2O_3, Nd_2O_3, Pm_2O_3, Sm_2O_3, Eu_2O_3, Gd_2O_3, Tb_2O_3, Dy_2O_3, Ho_2O_3, One or more sorts chosen from the group which consists of Er_2O_3, Tm_2O_3, Yb_2O_3, HfO_2, and Ta_2O_5 and WO_3 may be contained. As for the sum total of such content, it is preferred that it is 10% or less. There is a possibility that d may become large too much at more than 10%. It is 2% or less especially preferably 5% or less more preferably. As for the sum total of said content, when it contains one or more sorts chosen from said group, it is preferred that it is 0.1% or more. It is 1% or more more preferably. It is preferred to contain these neither to make d smaller.

[0029]Although the glass of this invention can be fabricated by float glass process, the down draw method, the pressing method, etc. to tabular, it is preferred that mass production fabricates with an easy float glass process. The glass of this invention can be manufactured, for example by the following methods. The raw material of each ingredient by which normal use is carried out is prepared so that it may become a target system, this is continuously supplied to a fusion furnace, and it heats and fuses at 1500-1600 **. This melting glass is fabricated to predetermined board thickness with a float glass process, and is cut after annealing. In this way, the obtained glass plate is used for one pair of glass substrates etc. which form the cell of a liquid crystal display.

[0030]

[Example]It prepared so that it might become a target system which shows the raw material of each ingredient to the column from SiO_2 of a table to ZnO by mol % display, and it dissolved at 1600 ** using platinum crucible. In the dissolution, it agitated using the platinum stirrer and glass was uniformed. Subsequently, it was begun to pour melting glass and post forming annealing was carried out tabular.

[0031]d (unit: g/cm^3) of the obtained glass, alpha (unit: $x10^{-7}$/**), E (unit: GPa), a specific Young's modulus (MNm/kg), a strain point (unit: **), T_4 (unit: **), T_L (unit: **), BHF-proof nature, and acid resistance are shown in a table.

[0032]With the simple hydrometer based on the Archimedes method, d measured T_4 the rotation viscometer, respectively by the method for which E is specified [alpha] to JIS-R3103 by the differential thermal expansion meter (TMA) the strain point with the bending resonance

method.

[0033]T_L held the glass grain which ground and obtained glass at 1100 ** for 17 hours, deposited the crystal inside the glass grain, and was calculated by investigating the temperature to which it heat-treats at various temperature next for 17 hours, and said crystal disappears.

[0034]BHF-proof nature was evaluated by observing the surface of a glass substrate, after polished glass was immersed for 20 minutes at 25 ** into said mixed liquor of ammonium fluoride solution and fluoric acid solution. What is not cloudy was made into O.

[0035]Acid resistance was evaluated by observing the surface of a glass substrate, after polished glass was immersed at 90 ** into said hydrochloric acid aqueous solution for 20 hours. The thing without change of appearance, such as nebula, was made into O.

[0036]It is an example, Examples 12 and 13 are glass conventionally, and Examples 1-11 are comparative examples.

[0037]

[Table 1]

	例1	例2	例3	例4	例5	例6	例7
SiO_2	67.0	69.0	71.0	66.0	70.0	66.0	70.0
Al_2O_3	11.5	12.5	11.5	13.5	11.5	13.5	12.0
B_2O_3	11.0	7.0	8.5	12.0	9.0	12.0	8.5
MgO	3.2	3.5	2.7	2.5	2.5	2.5	1.0
CaO	3.2	3.5	2.7	2.5	2.5	2.5	6.0
SrO	3.2	3.5	2.7	2.5	2.5	1.5	2.0
BaO	0	0	0	0	0	1.0	0
Y_2O_3	1.0	1.0	1.0	1.0	2.0	1.0	0.5
ZrO_2	0	0	0	0	0	0	0
ZnO	0	0	0	0	0	0	0
d	2.455	2.499	2.442	2.442	2.492	2.468	2.426
α	29.3	31.5	27.4	29.2	29.3	30.8	29.9
E	74.7	77.6	72.2	75.1	72.3	72.1	73.4
E／d	30.3	31.1	29.6	30.8	29.0	29.2	30.3
歪点	652	688	680	656	666	656	684
T_4	1296	1348	1368	1299	1347	1297	−
T_L	1280	1310	1290	1310	1350	1280	−
耐BHF性	○	○	○	○	○	○	○
耐酸性	○	○	○	○	○	○	○

[0038]

[Table 2]

	例８	例９	例１０	例１１	例１２	例１３
SiO_2	70.0	70.0	72.0	70.5	65.2	68.3
Al_2O_3	11.0	11.0	9.5	10.5	11.9	10.7
B_2O_3	8.0	8.0	7.0	7.5	7.3	7.9
MgO	6.0	4.0	2.0	2.5	8.4	5.8
CaO	2.0	6.0	9.0	5.5	3.0	2.0
SrO	2.0	0	0	2.5	1.3	0.7
BaO	0	0	0	0	2.0	3.8
Y_2O_3	1.0	1.0	0.5	1.0	0.6	0
ZrO_2	0	0	0	0	0.3	0.6
ZnO	0	0	0	0	0	0.4
d	2.446	2.422	2.396	2.468	2.490	2.510
α	28.5	29.4	31.9	32.2	35.7	35.9
E	77.5	76.2	74.4	74.8	76.1	74.3
E／d	31.7	31.5	31.1	30.3	30.6	29.6
歪点	675	680	687	680	686	671
T_4	—	—	—	—	—	—
T_L	—	—	—	—	—	—
耐ＢＨＦ性	○	○	○	○	—	—
耐酸性	○	○	○	○	—	—

[0039]

[Effect of the Invention]The suitable glass substrate for various displays, a photo mask, etc. which do not contain an alkali metal oxide on parenchyma, but are a high strain point, high Young's modulus, low density, and a low expansion coefficient, and are excellent in BHF-proof nature and acid resistance can be provided. By using this glass substrate, the weight saving of various displays, a productivity drive, etc. can be planned.

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)**公開特許公報（Ａ）**　(11)特許出願公開番号
特開2001－348247
（P2001－348247A）
(43)公開日　平成13年12月18日(2001.12.18)

(51)Int.Cl.'	識別記号	ＦＩ	ﾃｰﾏｺｰﾄﾞ(参考)
Ｃ０３Ｃ　3/095		Ｃ０３Ｃ　3/095	４Ｇ０６２

審査請求　未請求　請求項の数４　ＯＬ　（全　７　頁）

(21)出願番号　特願2000－163351(P2000－163351)

(22)出願日　平成12年５月31日(2000.5.31)

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最終頁に続く

(54)【発明の名称】　無アルカリガラス

(57)【要約】
【課題】低密度、高ヤング率等に加え低膨張係数の無アルカリガラスの提供。
【解決手段】モル%表示で、SiO_2：６０～７５、Al_2O_3：１～１６、B_2O_3：１～２０、ＭｇＯ：０～１０、ＣａＯ：０～１２、ＳｒＯ：０～１０、ＢａＯ：０～１．５、Y_2O_3：０．０５～５からなり、アルカリ金属酸化物を実質的に含有しない無アルカリガラス。

【特許請求の範囲】
【請求項1】下記酸化物基準のモル%表示で実質的に、
SiO_2　60～75%、
Al_2O_3　1～16%、
B_2O_3　1～20%、
MgO　0～10%、
CaO　0～12%、
SrO　0～10%、
BaO　0～1．5%、
Y_2O_3　0．05～5%、
からなり、アルカリ金属酸化物を実質的に含有しない無アルカリガラス。
【請求項2】密度が2．55g／cm³以下であり、かつ50～350℃における平均線膨張係数が34×10^{-7}／℃以下である請求項1に記載の無アルカリガラス。
【請求項3】P_2O_5、PbO、As_2O_3およびSb_2O_3のいずれも実質的に含有しない請求項1または2に記載の無アルカリガラス。
【請求項4】液相温度をT_L、粘度が10^4ポアズとなる温度をT_4として、T_L-T_4≦50℃である請求項1、2または3に記載の無アルカリガラス。
【発明の詳細な説明】
【0001】
【発明の属する技術分野】本発明は、フラットディスプレイ、フォトマスク等の基板に好適な無アルカリガラスに関する。
【0002】
【従来の技術】従来、ディスプレイ、フォトマスク等に用いられるガラス基板、特に表面に酸化物等の薄膜が形成されるガラス基板には、次に示す特性（1）～（4）が要求されていた。
（1）実質的にアルカリ金属酸化物を含有しないこと。これは、ガラス基板から前記薄膜中にアルカリ金属が拡散して薄膜特性が劣化することを防止するためである。
（2）歪点が高いこと。これは、前記薄膜を形成する工程が高温工程であり、この工程におけるガラス基板の熱変形およびガラス構造安定化に伴うガラス基板の収縮（熱収縮）を抑制するためである。
【0003】（3）半導体形成に用いられる各種薬品に対して充分な化学耐久性を有すること。特にSiO_xやSiN_xのエッチングのためのバッファードフッ酸（フッ酸＋フッ化アンモニウム；BHF）、ITO（InとSnの酸化物）のエッチングに用いられる塩酸、金属電極のエッチングに用いられるその他各種の酸（硝酸、硫酸等）、およびレジスト剥離液のアルカリに対して耐久性のあること。
（4）内部および表面に泡、脈理、インクルージョン（内包異物）、ピット（くぼみ）、キズ等がないこと。
【0004】
【発明が解決しようとする課題】近年、上記（1）～（4）の特性に加え、次に示す特性（5）～（7）も要求されるようになってきた。
（5）密度が小さいこと。これは、ディスプレイの軽量化が求められているからである。
（6）ヤング率が大きいこと。これは、前記ディスプレイの軽量化のためにガラス基板の薄板化が望まれており、この薄板化によるガラス基板のたわみ増加を抑制するためである。
（7）熱膨張係数が小さいこと。これは、ディスプレイの熱処理工程における昇降温速度を大きくし、ディスプレイの生産性を向上させるためである。
【0005】一方、特開2000－44278の表1および表2には密度が2．50～2．60g／cm³、ヤング率が74．1～78．9GPa、熱膨張係数が34．1～41．4×10^{-7}／℃の範囲にあるディスプレイ用ガラス（以下従来ガラスという。）が開示されている。しかし、ディスプレイの生産性向上等のために前記従来ガラスよりもさらに熱膨張係数の小さいガラスが求められている。本発明は、以上の課題を解決する無アルカリガラスの提供を目的とする。
【0006】
【課題を解決するための手段】本発明は、下記酸化物基準のモル%表示で実質的に、
SiO_2　60～75%、
Al_2O_3　1～16%、
B_2O_3　1～20%、
MgO　0～10%、
CaO　0～12%、
SrO　0～10%、
BaO　0～1．5%、
Y_2O_3　0．05～5%、
からなり、アルカリ金属酸化物を実質的に含有しない無アルカリガラスを提供する。
【0007】
【発明の実施の形態】本発明の無アルカリガラス（以下本発明のガラス）の密度dは2．55g／cm³以下であることが好ましい。2．55g／cm³超ではディスプレイの軽量化が困難になるおそれがある。より好ましくは2．50g／cm³以下、特に好ましくは2．45g／cm³以下である。
【0008】本発明のガラスの50～350℃における平均線膨張係数αは34×10^{-7}／℃以下であることが好ましい。34×10^{-7}／℃超では、ディスプレイの熱処理工程における昇降温速度を大きくできないおそれがある。より好ましくは32×10^{-7}／℃以下、特に好ましくは30×10^{-7}／℃以下である。
【0009】本発明のガラスのヤング率Eは72GPa以上であることが好ましい。72GPa未満では、ガラスの自重によるガラス基板のたわみが大きくなるおそれがある。より好ましくは74GPa以上、特に好ましく

は76GPa以上である。

【0010】本発明のガラスの比弾性率（＝E／d）は27MNm／kg以上であることが好ましい。27MNm／kg未満では前記ガラス基板のたわみが大きくなるおそれがある。より好ましくは29MNm／kg以上、特に好ましくは30MNm／kg以上である。

【0011】本発明のガラスの歪点は650℃以上であることが好ましい。650℃未満では前記熱収縮が大きくなりすぎるおそれがある。より好ましくは660℃以上、特に好ましくは665℃以上、最も好ましくは675℃以上である。

【0012】本発明のガラスの液相温度T_Lは1400℃以下であることが好ましい。1400℃超ではガラス製造時に失透するおそれがある。より好ましくは1370℃以下、特に好ましくは1350℃以下、最も好ましくは1300℃以下である。

【0013】T_Lから粘度が10^4ポアズとなる温度T_4を減じた「T_L-T_4」は50℃以下であることが好ましい。50℃超では成形時に失透する等の問題が生じ、ガラスの製造が困難になるおそれがある。より好ましくは30℃以下、特に好ましくは0℃以下である。

【0014】次に、本発明のガラスの耐BHF性について述べる。本発明のガラスを、質量百分率表示濃度が40%であるフッ化アンモニウム水溶液と同表示濃度が50%であるフッ酸水溶液とを体積比で9：1に混合した液中に25℃で20分間浸漬したとき、その表面が白濁しないことが好ましい。また、ガラスの体積と前記浸漬によるガラスの質量変化とから求めたガラスの単位体積当りの質量減少が0．6mg／cm³以下であることが好ましい。

【0015】次に、本発明のガラスの耐酸性について述べる。本発明のガラスを、濃度が0．1モル／リットルである塩酸水溶液中に90℃で20時間浸漬したとき、その表面に白濁、変色、クラック等が生じないことが好ましい。また、ガラスの体積と前記浸漬によるガラスの質量変化とから求めたガラスの単位体積当りの質量減少が0．6mg／cm³以下であることが好ましい。より好ましくは0．2mg／cm³以下である。

【0016】本発明のガラスは、下記酸化物基準のモル%表示で実質的に、

SiO_2	64～74%、
Al_2O_3	5～14%、
B_2O_3	5～12%、
MgO	0～6%、
CaO	0～10%、
SrO	0～6%、
BaO	0～1．5%、
Y_2O_3	0．05～3%、

からなり、アルカリ金属酸化物、PbO、P_2O_5、As_2O_3およびSb_2O_3のいずれも実質的に含有しないことが好ましい。

【0017】次に、本発明のガラスの組成について、モル%を単に%と表記して説明する。SiO_2はネットワークフォーマーであり、また、dを小さくする効果、または歪点を高くする効果があり、必須である。75%超では、ガラス溶解が困難になる、またはT_Lが高くなりすぎる。好ましくは74%以下、より好ましくは73%以下である。60%未満では、dが大きくなる、歪点が低下する、αが大きくなりすぎる、または化学的耐久性が低下する。好ましくは62%以上、より好ましくは64%以上、特に好ましくは66%以上である。

【0018】Al_2O_3はガラスを安定化させ、歪点を上げ、またはEを大きくする効果があり、必須である。16%超では、T_Lが高くなりすぎる、耐BHF性が低下する、または耐酸性が低下する。好ましくは14%以下、より好ましくは13%以下である。1%未満では前記効果が小さくなりすぎる。より好ましくは3%以上、特に好ましくは5%以上である。

【0019】B_2O_3は、dを小さくする、耐BHF性を高くする、ガラス溶解を容易にする、T_Lを低下させる、またはαを小さくする効果を有し、必須である。20%超では、歪点が低下する、Eが小さくなりすぎる、または耐酸性が低下する。好ましくは16%以下、より好ましくは12%以下、特に好ましくは9%以下である。1%未満では前記効果が小さくなりすぎる。より好ましくは3%以上、特に好ましくは5%以上である。

【0020】MgOは必須ではないが、ガラス溶解を容易にする、またはEを大きくするために10%まで含有してもよい。10%超では、T_Lが高くなりすぎる、耐BHF性が低下する、または耐酸性が低下するおそれがある。好ましくは8%以下、より好ましくは6%以下である。MgOを含有する場合、その含有量は1%以上であることが好ましい。

【0021】CaOは必須ではないが、ガラス溶解を容易にする、Eを大きくする、またはガラスを安定化させるために12%まで含有してもよい。12%超ではT_Lが高くなりすぎる、またはαが大きくなりすぎるおそれがある。好ましくは10%以下、より好ましくは8%以下、特に好ましくは6%以下である。CaOを含有する場合、その含有量は1%以上であることが好ましい。

【0022】SrOは必須ではないが、ガラス溶解を容易にする、またはガラスを安定化させるために10%まで含有してもよい。10%超ではT_Lが高くなりすぎる、dが大きくなりすぎる、またはαが大きくなりすぎるおそれがある。好ましくは6%以下、より好ましくは4%以下である。SrOを含有する場合、その含有量は1%以上であることが好ましい。

【0023】BaOは必須ではないが、ガラスの分相を抑制するために、またはT_Lを低下させるために1．5%まで含有してもよい。1．5%超ではdが大きくなり

すぎる。好ましくは1%以下である。dをより小さくしたい場合はBaOを実質的に含有しないことが好ましい。

【0024】MgO、CaO、SrOおよびBaOの含有量の合計MgO+CaO+SrO+BaOは5～15%であることが好ましい。15%超ではdまたはαが大きくなりすぎるおそれがある。好ましくは13%以下、より好ましくは11%以下である。5%未満では、ガラスの溶解性が低下する、またはEが小さくなりすぎるおそれがある。好ましくは6%以上、より好ましくは7%以上である。

【0025】Y_2O_3はガラス溶解を容易にし、またEを大きくする効果を有し、必須である。5%超ではT_Lが高くなりすぎる、耐BHF性が低下する、または耐酸性が低下する。好ましくは3%以下、より好ましくは2%以下である。0.05%未満では前記効果が小さくなりすぎる。好ましくは0.1%以上、より好ましくは0.5%以上である。

【0026】本発明のガラスは実質的に上記成分からなるが、本発明の目的を損なわない範囲で他の成分を含有してもよい。前記他の成分の含有量の合計は15%以下であることが好ましい。より好ましくは10%以下である。

【0027】次に、前記他の成分について述べる。ガラスの溶解性、清澄性または成形性を改善するために、Fe_2O_3、SO_3、F、Cl、SnO_2、As_2O_3、Sb_2O_3等を合計で5%まで含有してもよい。なお、As_2O_3、Sb_2O_3またはPbOは環境対策等のための管理が必要であり、この観点からはいずれも含有しないことが好ましい。また、P_2O_5はガラスの化学的耐久性を低下させるおそれがあり、含有しないことが好ましい。

【0028】Eを大きくするために、ZnO、TiO_2、ZrO_2、V_2O_5、Cr_2O_3、MnO、CoO、NiO、CuO、Ga_2O_3、GeO_2、Nb_2O_5、MoO_3、CeO_2、Pr_2O_3、Nd_2O_3、Pm_2O_3、Sm_2O_3、Eu_2O_3、Gd_2O_3、Tb_2O_3、Dy_2O_3、Ho_2O_3、Er_2O_3、Tm_2O_3、Yb_2O_3、HfO_2、Ta_2O_5およびWO_3からなる群から選ばれる1種以上を含有してもよい。これらの含有量の合計は10%以下であることが好ましい。10%超ではdが大きくなりすぎるおそれがある。より好ましくは5%以下、特に好ましくは2%以下である。前記群から選ばれる1種以上を含有する場合、前記含有量の合計は0.1%以上であることが好ましい。より好ましくは1%以上である。なお、dをより小さくしたい場合はこれらのいずれも含有しないことが好ましい。

【0029】本発明のガラスは、フロート法、ダウンドロー法、プレス法等で板状に成形できるが、大量生産が容易なフロート法で成形することが好ましい。本発明のガラスは、たとえば次のような方法で製造できる。通常使用される各成分の原料を目標組成となるように調合し、これを溶解炉に連続的に投入し、1500～1600℃に加熱して溶融する。この溶融ガラスをフロート法により所定の板厚に成形し、徐冷後切断する。こうして得られたガラス板は液晶ディスプレイのセルを形成する1対のガラス基板等に使用される。

【0030】

【実施例】各成分の原料を表のSiO_2からZnOまでの欄にモル%表示で示す目標組成となるように調合し、白金坩堝を用いて1600℃で溶解した。溶解にあたっては、白金スターラを用いて撹拌しガラスを均質化した。次いで溶融ガラスを流し出し、板状に成形後徐冷した。

【0031】得られたガラスのd（単位：g／cm^3）、α（単位：×10^{-7}／℃）、E（単位：GPa）、比弾性率（MNm／kg）、歪点（単位：℃）、T_4（単位：℃）、T_L（単位：℃）、耐BHF性、耐酸性を表に示す。

【0032】dはアルキメデス法に基づく簡易比重計により、αは示差熱膨張計（TMA）により、Eは曲げ共振法により、歪点はJIS-R3103に規定されている方法により、T_4は回転粘度計により、それぞれ測定した。

【0033】T_Lは、ガラスを粉砕して得たガラス粒を1100℃に17時間保持してガラス粒内部に結晶を析出させ、次に種々の温度で17時間熱処理して前記結晶が消失する温度を調べることにより求めた。

【0034】耐BHF性は、研磨したガラスをフッ化アンモニウム水溶液とフッ酸水溶液の前記混合液中に25℃で20分間浸漬した後、ガラス基板の表面を観察することによって評価した。白濁していないものを○とした。

【0035】耐酸性は、研磨したガラスを前記塩酸水溶液中に90℃で20時間浸漬した後、ガラス基板の表面を観察することによって評価した。白濁等外観の変化のないものを○とした。

【0036】例1～11は実施例、例12、13は従来ガラスであり比較例である。

【0037】

【表1】

	例1	例2	例3	例4	例5	例6	例7
SiO_2	67.0	69.0	71.0	66.0	70.0	66.0	70.0
Al_2O_3	11.5	12.5	11.5	13.5	11.5	13.5	12.0
B_2O_3	11.0	7.0	8.5	12.0	9.0	12.0	8.5
MgO	3.2	3.5	2.7	2.5	2.5	2.5	1.0
CaO	3.2	3.5	2.7	2.5	2.5	2.5	6.0
SrO	3.2	3.5	2.7	2.5	2.5	1.5	2.0
BaO	0	0	0	0	0	1.0	0
Y_2O_3	1.0	1.0	1.0	1.0	2.0	1.0	0.5
ZrO_2	0	0	0	0	0	0	0
ZnO	0	0	0	0	0	0	0
d	2.455	2.499	2.442	2.442	2.492	2.468	2.426
α	29.3	31.5	27.4	29.2	29.3	30.8	29.9
E	74.7	77.6	72.2	75.1	72.3	72.1	73.4
E／d	30.3	31.1	29.6	30.8	29.0	29.2	30.3
歪点	652	688	680	656	666	656	684
T_4	1296	1348	1368	1299	1347	1297	—
T_L	1280	1310	1290	1310	1350	1280	—
耐BHF性	○	○	○	○	○	○	○
耐酸性	○	○	○	○	○	○	○

【0038】 【表2】

	例８	例９	例１０	例１１	例１２	例１３
SiO_2	70.0	70.0	72.0	70.5	65.2	68.3
Al_2O_3	11.0	11.0	9.5	10.5	11.9	10.7
B_2O_3	8.0	8.0	7.0	7.5	7.3	7.9
MgO	6.0	4.0	2.0	2.5	8.4	5.8
CaO	2.0	6.0	9.0	5.5	3.0	2.0
SrO	2.0	0	0	2.5	1.3	0.7
BaO	0	0	0	0	2.0	3.8
Y_2O_3	1.0	1.0	0.5	1.0	0.6	0
ZrO_2	0	0	0	0	0.3	0.6
ZnO	0	0	0	0	0	0.4
d	2.446	2.422	2.396	2.468	2.490	2.510
α	28.5	29.4	31.9	32.2	35.7	35.9
E	77.5	76.2	74.4	74.8	76.1	74.3
E／d	31.7	31.6	31.1	30.3	30.6	29.6
歪点	675	680	687	680	686	671
T_4	—	—	—	—	—	—
T_L	—	—	—	—	—	—
耐ＢＨＦ性	○	○	○	○	—	—
耐酸性	○	○	○	○	—	—

【００３９】

【発明の効果】アルカリ金属酸化物を実質上含有せず、高歪点、高ヤング率、低密度、低膨張係数であって、耐ＢＨＦ性、耐酸性に優れる、各種ディスプレイ、フォトマスク等に好適なガラス基板を提供できる。このガラス基板を用いることにより、各種ディスプレイの軽量化、生産性向上等を図れる。

フロントページの続き

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Fターム(参考) 4G062 AA18 BB01 BB05 CC10 DA06
DA07 DB03 DB04 DC03 DC04
DD01 DE01 DF01 EA01 EA10
EB01 EC01 ED01 ED02 ED03
EE01 EE02 EE03 EE04 EF01
EF02 EF03 EG01 EG02 EG03
FA01 FB01 FC01 FD01 FE01
FF01 FG01 FH01 FJ02 FJ03
FK01 FL01 GA01 GA10 GB01
GC01 GD01 GE01 HH01 HH03
HH05 HH07 HH09 HH11 HH13
HH15 HH17 HH20 JJ01 JJ03
JJ05 JJ07 JJ10 KK01 KK03
KK05 KK07 KK10 MM27 NN30
NN33 NN34

ALKALI-FREE GLASS SUBSTRATE

Publication number: JP2004189535
Publication date: 2004-07-08
Inventor: MIWA SHINKICHI
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Classification:
- international: ***G02F1/1333; C03C3/091; C03C3/093; C03C3/11; C03C4/00; H01L51/50; H05B33/02; H05B33/14;*** **G02F1/13; C03C3/076; C03C4/00; H01L51/50; H05B33/02; H05B33/14;** (IPC1-7): C03C3/091; C03C3/093; C03C3/11; G02F1/1333; H05B33/02; H05B33/14
- European: C03C4/00U; C03C3/091; C03C3/093; C03C3/11
Application number: JP20020359046 20021211
Priority number(s): JP20020359046 20021211

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Abstract of **JP2004189535**
PROBLEM TO BE SOLVED: To provide an alkali-free glass substrate which has a high transmittance without increasing its cost while satisfactorily acquiring all the characteristics required by a liquid crystal display.
SOLUTION: The alkali-free glass substrate does not substantially contain an alkali metal oxide, contains, by mass, 0.01-0.3% SnO<SB>2</SB>, 0-0.1% As<SB>2</SB>O<SB>3</SB>, and 0-1.0% Sb<SB>2</SB>O<SB>3</SB>, and has a Fe content in glass of 0.005-0.03 mass% in terms of Fe<SB>2</SB>O<SB>3</SB>.
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[Title of the Invention}

ALKALI-FREE GLASS SUBSTRATE

[Abstract]

[Object]

An object of the present invention is to provide a high-transmittance alkali-free glass substrate that fulfills all the requirements made of a liquid crystal display (LCD) without increasing costs.

[Constitution]

The alkali-free glass substrate according to the present invention contains substantially no alkali metal oxide, and comprises, by weight, 0.01-0.3% SnO_2, 0-0.1% As_2O_3, and 0-1.0% Sb_2O_3, and the Fe content of the glass, converted to Fe_2O_3, is 0.005-0.03% by weight.

[Selected Figures]

None

[Claims]

1. An alkali-free glass substrate containing substantially no alkali metal oxide and comprising, by weight, 0.01-0.3% SnO2, 0-0.1% As_2O_3, and 0-1.0% Sb_2O_3, wherein the Fe content of the glass, converted into Fe_2O_3, is 0.005-0.03% by weight.

2. The alkali-free glass substrate according to Claim 1, wherein the transmittance of said glass substrate is 50% or more for a wavelength of 300nm, and 89% or more for wavelengths of 400-800nm.

3. The alkali-free glass substrate according to Claim 1 or Claim 2, comprising, by weight, 55-70% SiO_2, 12-20% Al_2O_3, 5-15% B_2O_3, 0-5% MgO, 0-12% CaO, 0-10% SrO, 0-10% BaO, 0-5% ZnO, 0-5% ZrO_2, and 0-0.5% Cl.

[Detailed Description of the Invention]

[0001]

[Industrial Field of Application]

The present invention relates to an alkali-free glass substrate for use as a substrate in flat-panel displays such as liquid crystal displays, electroluminescent displays, field emission displays, and sensors, or as cover glass for a solid-state image sensor.

[0002]

[Prior Art]

Alkali-free glass substrates have been widely used in the past as substrates for flat-panel displays and sensors, and as cover glass for solid-state image sensors.

[0003]

A transparent conductive film, an insulating film, a semi-conductor film, and a metal film are deposed on the surface of a glass substrate of this type, and various types of circuits and patterns are formed thereon by photolithographic etching (photo etching). During these processes, the glass substrate is subjected to heat treatment at temperatures of several hundred degrees, as well as to treatment by various chemicals, including sulfuric acid,

hydrochloric acid, alkali solutions, hydrofluoric acid, and buffered hydrofluoric acid.

[0004]

The following characteristics are required of a glass substrate of this kind.

(1) It should contain essentially no alkali metal oxide, since alkali metal oxides contained in the glass can cause alkali ions in the semi-conductor materials that are deposed on the substrate as a film during heat treatment to diffuse, leading to deterioration in film characteristics.

(2) It should have sufficient chemical resistance to withstand the various acids and alkalis used during the photo-etching process without deteriorating.

(3) It should have a high strain point, so that the glass substrate does not exhibit heat contraction during film deposition and other stages of the TFT (thin film transistor) formation process. In concrete terms, it should have a strain point of 640° C or more. A glass substrate for use with a polycrystalline silicon TFT-type LCD requiring a working temperature of 600° C or more, for example, requires a strain point of 640 ° C or more.

[0005]

In addition, the following characteristics are also required.

(4) It should have excellent meltability, to prevent

defects occurring during the melting process that would make the glass unsuitable for use as a substrate.

(5) It should have a low heat expansion coefficient, to improve heat shock resistance and to reduce damage sustained during the heat treatment process.

[0006]

Furthermore, because transmittance is an extremely important consideration for glass substrates used in devices of this kind, the glass substrate should preferably have high transmittance from the ultraviolet range through to the visible range.

[0007]

In the case of an LCD, for example, which is a non-light emitting display with poor light utilization efficiency, the transmittance of the glass substrate should be as high as possible within the visible range. Further, the TFT (thin film resistor) elements are formed on the substrate after the deposition of the transparent conductive film, insulating film, semiconductor film, and metal film by the back-exposure method of photo etching, which involves irradiating ultraviolet rays with a wavelength of approximately 300nm from the back face of the glass substrate. For this reason, transmittance within the ultraviolet range also needs to be as high as possible.

[0008]

Organic electroluminescent displays, which display by illuminating red, green, and blue organic phosphors, have been

attracting considerable notice in recent years. In these displays, the luminous efficiency of the phosphors that emit green light is lower than that of the other phosphors. For this reason, glass used as a substrate in this kind of display needs to have high transmittance within the wavelength range corresponding to green light.

[0009]

[Patent Document 1]

Japanese Unexamined Patent Publication No. H7-202208

[Patent Document 2]

Japanese Unexamined Patent Publication No. 2001-261366

[0010]

[Problem to be Solved by the Invention]

Fe_2O_3 exists within the glass as Fe^{3+} and Fe^{2+}. Fe^{3+} in particular has its absorption peak at approximately 380nm, and reduces transmittance for the ultraviolet range and the low-wavelength end of the visible range. Low-cost, mass-produced glass generally contains large amounts of Fe_2O_3, which is mixed in with the raw materials and also enters the batch during the manufacturing process. Because of this, it is accepted that if this kind of glass is used as a substrate in a display or sensor, low transmittance for the ultraviolet range and the low-wavelength end of the visible range will result in reduced performance.

[0011]

In order to eradicate Fe_2O_3 entirely from the glass, it

would be necessary to select high-purity raw materials, and to use specially designed manufacturing equipment to prevent any Fe_2O_3 from the batch preparation equipment becoming mixed in with the raw materials. This would increase manufacturing costs dramatically, and is therefore unrealistic.

[0012]

An object of the present invention is to provide a high-transmittance alkali-free glass substrate that fulfils all of the requirements (1) to (5) outlined above, without increasing production costs.

[0013]

[Means for Solving the Problem]

After various experiments, the inventors of the present invention found that the desired transmittance could be obtained by adding SnO_2 to the glass, and these findings have led them to propose the present invention.

[0014]

The alkali-free glass substrate according to the present invention is characterized in that it contains essentially no alkali metal oxide and comprises, by weight, 0.01-0.3% SnO_2, 0-0.1% As_2O_3, 0-1.0% Sb_2O_3, and has an Fe content of 0.005-0.03% by weight, converted to Fe_2O_3.

[0015]

[Operation]

Generally speaking, the ultraviolet rays used when forming a TFT on a glass substrate chiefly have wavelengths of

approximately 300nm. Because of this, it is important that the transmittance of the glass substrate for a wavelength of 300nm should be as high as possible, and at least 50% or more (preferably 60% or more). A transmittance of less than 50% is likely to mean that more time is required for carrying out back-exposure and forming the TFT, hindering productivity.

[0016]

Also, because an LCD is a non-light emitting display, any loss of light utilization efficiency should be kept as low as possible. For this reason, a glass substrate for use in an LCD should have transmittance that is as high as possible for the visible range. It is important that the transmittance of a glass substrate of this type should be 89% or more (and preferably 90% or more) for wavelengths of 400-800nm. Transmittance of less than 89% can adversely affect display performance.

[0017]

The As_2O_3 content of the glass in the alkali-free glass substrate according to the present invention is therefore limited to no more than 0.1%, and 0.01-0.3% of SnO_2 is added. This causes the Fe valence to change from 3 (Fe^{3+}) to 2 (Fe^{2+}), giving the glass substrate transmittance of 50% or more for wavelengths of 300nm and transmittance of 89% or more for wavelengths of 400-800nm.

[0018]

Adding 0.01-0.3% of SnO_2 to the glass is believed to cause

the following reaction to take place: $Sn^{2+} + 2Fe^{3+} \rightarrow Sn^{4+} + 2Fe^{2+}$. The valence of the Fe changes, so that the amount of Fe^{2+} increases while the amount of Fe^{3+} decreases, and transmittance for the ultraviolet range and the low-wavelength end of the visible range improves. An amount of SnO_2 less than 0.01% is not desirable, as in this case only a small amount of Fe changes valence, and transmittance for the ultraviolet range and the low wavelength end of the visible range decreases. An amount greater than 0.3%, on the other hand, is also undesirable, since this is liable to cause SnO_2 crystals to be deposited in the glass. A preferable range of SnO_2 content is 0.05-0.3%. Although several other substances besides Sn, such as Ce and Ti, also cause Fe valence to change in a similar way, these should not be used, as they have their absorption peaks in the ultraviolet range.

[0019]

AS_2O_3, which is widely used as a fining agent, also has its absorption peak in the ultraviolet range. It also acts to inhibit the valence change to Fe^{2+} brought about by the SnO_2. For this reason, the amount of As_2O_3 contained in the glass is limited to no more than 0.1%. An amount of As_2O_3 greater than 0.1% is not desirable, as this reduces transmittance for the ultraviolet range. The As_2O_3 content should preferably be no more than 0.5%. Reducing the amount of As_2O_3 used as a fining agent in an alkali-free glass makes it more difficult to obtain bubble-free glass. However, since the SnO_2 added to

improve transmittance also acts as a fining agent, it is possible to obtain bubble-free glass by combining this with suitable amounts of Sb_2O_3 and Cl. Like As_2O_3, however, Sb_2O_3 has its absorption peak in the ultraviolet range, so that the Sb_2O_3 content should be limited to no more than 1.0%.

[0020]

If the amount of Fe^{2+} in the glass increases too much as the result of adding SnO_2 there is a risk that transmittance for the high-wavelength end of the visible range might be reduced, since Fe^{2+} has an absorption peak of approximately 1080nm. This would make it impossible to maintain transmittance at 89% or more for wavelengths of 400-800nm. To prevent this, it is necessary to adjust the total amount of Fe contained in the glass, which must be kept within a range of 0.005-0.03%, converted to Fe_2O_3. It is not desirable that the amount of Fe_2O_3 is over 0.03%, as this lowers transmittance at the high-wavelength end of the visible range. Attempting to reduce the Fe_2O_3 content any lower than 0.005%, however, is not advisable, as this makes costs unacceptably high. A preferable range of Fe_2O_3 content is 0.007-0.03%.

[0021]

The glass used in the present invention is an alkali-free glass. The reason for this is that if the glass contains alkali metal oxides (Na_2O, K_2O, Li_2O), not only does the alkali content of the glass adversely affect the characteristics of the various films and TFT elements formed on the glass

substrate, but there is also a risk that clouding will be produced by reactions between the alkaline constituents of the glass and the various films, leading to a reduction in the transmittance of the substrate.

[0022]

The precise composition of the glass substrate according to the present invention may be determined as suitable according to use, taking into consideration factors such as chemical resistance, thermal contraction, meltability, moldability, and thermal expansion coefficient. One example of a suitable composition would be an alkali glass comprising, as a percentage of the total weight: 55-70% SiO_2, 12-20% Al_2O_3, 5-15% B_2O_3, 0-5% MgO, 0-12% CaO, 0-10% SrO, 0-10% BaO, 0-5%ZnO, 0-5% ZrO_2, and 0-0.5% Cl.

[0023]

An explanation follows of the reasons for the ranges given for the composition of the glass above.

[0024]

SiO_2 acts as the network former of the glass, and has the effect of improving the acid resistance of the glass, increasing the strain point of the glass, and reducing the thermal contraction of the glass substrate. A glass substrate with high acid resistance and low thermal contraction can be obtained with an SiO_2 content of 55-70%. A preferable range is 57-67%. A higher SiO_2 content causes the high-temperature viscosity of the glass to increase, so that meltability

deteriorates and devitrified cristobalite is more likely to be deposited in the glass. Reducing the content any lower than this range tends to reduce the acid resistance and strain point of the glass.

[0025]

Al_2O_3 increases the strain point of the glass and helps to prevent deposits of devitrified cristobalite in the glass. A glass substrate with low liquid phase temperature can be obtained with an Al_2O_3 content of 12-20%. A preferable range is 13-18%. A higher Al_2O_3 content tends to adversely affect the buffered hydrofluoric acid resistance of the glass, and is also liable to increase the liquid phase temperature, making the glass more difficult to mold. An Al_2O_3 content of less than the suggested range tends to reduce the strain point of the glass.

[0026]

B_2O_3 acts as a flux, lowering the viscosity of the glass and improving meltability. These effects can be obtained with a B_2O_3 content of 5-15%. A preferable range is 7-14%. Greater amounts of B_2O_3 tend to lower the strain point of the glass and adversely affect acid resistance. Lower amounts of Ba_2O_3, on the other hand, are ineffective as a flux, and tend to reduce the meltability of the glass.

[0027]

MgO reduces only the high-temperature viscosity of the glass without reducing the strain point, and improves the

meltability of the glass. The meltability of the glass can be improved by a MgO content of 5% or less. A preferable range is 0-3%. Larger amounts of MgO are liable to cause devitrified enstatite to be deposited in the glass. Buffered hydrofluoric acid resistance is also reduced, leading to erosion of the surface of the glass substrate during the photo-etching process and causing reactive substances to adhere to the surface of the glass, making clouding of the glass substrate more likely.

[0028]

CaO reduces only the high-temperature viscosity of the glass without lowering the strain point, and greatly improves the meltability of the glass. Meltability can be improved by a CaO content of 12% or lower. A preferable range is 3-10%. Larger amounts of CaO tend to adversely affect buffered hydrofluoric acid resistance.

[0029]

SrO improves the chemical resistance and devitrification resistance of the glass. This effect can be obtained with a SrO content of 10% or less. A preferable range is 0-7%. Larger amounts of SrO may increase the density and thermal expansion coefficient of the glass, and tend adversely affect meltabililty.

[0030]

BaO improves the chemical resistance and devitrification resistance of the glass in a similar way to SrO. This effect

can be obtained with a BaO content of 10% or less. A preferable range is 0-5%. Larger amounts BaO may increase the density and thermal expansion coefficient of the glass, and tend to have seriously adverse effects on meltability.

[0031]

ZnO improves the buffered hydrofluoric acid resistance of the glass. This effect can be obtained with a ZnO content of 3% or less. A preferable range is 0-2.5%. Larger amounts of ZnO, however, tend to lower the devitrification resistance and strain point of the glass.

[0032]

It should be noted that although the alkaline earth metal oxides MgO, CaO, SrO, and BaO are mixed and added to the batch to help improve the meltability and devitrification resistance of the glass, a large amount of these constituents tends to increase the density of the glass, making it difficult to obtain a lightweight glass substrate. Consequently, the total amount of these substances contained in the glass should be less than 11%.

[0033]

ZrO_2 improves the acid resistance of the glass. This effect can be obtained with a ZrO_2 content of 1% or less. A preferable range is 0-0.7%. With larger amounts of ZrO_2, devitrified zircon is liable to be deposited in the glass.

[0034]

Cl acts as a fining agent. Large amounts of Cl may

increase volatility from the glass melt and make striation more likely. However, the desired effect can be readily obtained with a Cl content of 0.5% or less. A preferable range is 0-0.4%.

[0035]

Next, an explanation follows of a method for manufacturing an alkali-free glass according to the present invention.

[0036]

First, the raw materials of the alkali-free glass are selected, taking into consideration the amount of Fe contained as an impurity. The batch is then prepared from these materials in line with the recommended range for each constituent given above. The prepared batch is then melted in a continuous melt furnace at a temperature of 1520-1680° C. The molten glass is then molded into sheet form using the slot down draw, overflow down draw, float, or roll out method or similar and slow-cooled to produce an alkali-free glass substrate.

[0037]

A detailed explanation of the present invention follows based on several examples.

[0038]

Tables 1-4 show examples of the present invention (samples 1-20), and Table 5 shows comparison examples (samples 21 and 22).

[0039]

[Table 1]

Example

Composition (%)

Total Fe_2O_3

Transmittance (%)

Density (g/cm2)

Thermal Expansion Coefficient

Strain Point

Liquid Phase Temperature

Acid Resistance

Buffered Hydrofluoric Acid Resistance

[0040]

[Table 2]

{As for Table 1}

[0041}

{Table 3}

{As for Table 1}

[0042}

{Table 4}

[As for Table 1]

[0043]

[Table 5]

[As for Table 1]

[0044]

Each of the samples shown in the tables was made as

follows.

[0045]

First, the batch of raw materials was prepared in line with the composition given in the tables. After melting for 24 hours at 1600° C in a platinum pot, the molten glass was poured out onto a carbon plate and molded into sheet form. This sheet of glass was then optically polished on both sides to make a large, thin glass substrate having a width of 300mm, a height of 300mm, and a thickness of 0.7mm.

[0046]

The characteristics of each of these samples were then evaluated. The results are given in the tables.

[0047]

As the tables make clear, samples 1 to 20 (which were examples of the present invention) had transmittance of 55% or more for a wavelength of 300nm, and transmittance of 90% or more for wavelengths of 400-800nm. The density was low (no more than 2.43g/cm^2), allowing for a more lightweight substrate. The thermal expansion coefficient was 30-34 x 10^{-7}/° C. The strain point was high (665° C or more), allowing a glass substrate exhibiting little thermal contraction to be obtained. Further, the temperature corresponding to $10^{2.5}$ poise was no greater than 1610° C, and the liquid phase temperature was no greater than 1120° C, so that these samples had excellent meltability and moldability. Acid resistance and BHF

resistance were also excellent.

[0048]

Transmittance for wavelengths of 300nm for samples 21 and 22 (which were the comparative examples), however, was low, at no more than 40%.

[0049]

Transmittance was measured by taking samples using a spectrophotometer for wavelengths of 300nm, 400nm, 600nm, and 800nm.

[0050]

Density was measured using the well-known Archimedes method.

[0051]

Thermal expansion coefficients were calculated by measuring the average thermal expansion coefficient between 30° C and 380° C using a dilatometer.

[0052]

The strain point was measured using the method outlined in ASTM C336-71. The lower this value, the smaller the thermal contraction of the glass. Log η at $10^{2.5}$ shows the temperature corresponding to the high-temperature viscosity of $10^{2.5}$ poise. The lower this temperature, the better the meltability of the glass.

[0053]

The liquid phase temperature was assessed as follows.

First, each sample was crushed into pieces of 300-500μm in size and washed, then placed in a platinum pot and transferred to a temperature gradient furnace at 1000-1300° C. After 24 hours, the platinum pot was taken out from the temperature gradient furnace and the glass removed from the platinum pot. The samples obtained in this way were then examined through a polarizing microscope and the point of crystal deposition measured. This was taken to be the liquid phase temperature.

[0054]

HCl resistance was evaluated by immersing each sample for 3 hours in an aqueous solution kept at 80° C comprising 10% hydrochloric acid by weight and then examining the condition of the surface of the glass with the naked eye. Buffered hydrofluoric acid resistance was evaluated by immersing each sample for 30 minutes in a buffered hydrofluoric acid solution kept at 20° C comprising 30% ammonium fluoride and 6% hydrofluoric acid by weight and then examining the condition of the surface of the glass with the naked eye. Cases in which no alteration was discernable in the surface of the glass are shown with the symbol ○, and cases in which alteration was discernable are shown with the symbol X.

[0055]

[Effect of the Invention]

As described above, the alkali-free glass substrate according to the present invention has high transmittance

across the visible range, making it ideal for use as a substrate in a flat panel display or sensor, or as cover glass for a solid-state image sensor. Transmittance is also high in the ultraviolet range, making it particularly well suited for use as an alkali-free glass substrate in a TFT active matrix LCD display in which the TFT elements are formed using back-exposure.

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2004-189535
(P2004-189535A)
(43)公開日　平成16年7月8日(2004.7.8)

(51)Int.Cl.[7]	F I		テーマコード（参考）
C03C 3/091	C03C	3/091	2H090
C03C 3/093	C03C	3/093	3K007
C03C 3/11	C03C	3/11	4G062
G02F 1/1333	G02F	1/1333 500	
H05B 33/02	H05B	33/02	

審査請求 未請求　請求項の数 3　OL　（全 13 頁）　最終頁に続く

(21)出願番号　特願2002-359046(P2002-359046)
(22)出願日　平成14年12月11日(2002.12.11)

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Fターム(参考)　2H090 JB02 JD01 JD09 JD18 LA04
3K007 AB03 AB17 AB18 CA01 DB03

最終頁に続く

(54)【発明の名称】無アルカリガラス基板

(57)【要約】
【目的】液晶ディスプレイに求められる要求特性を全て満足し、しかも、コストを上げることなく、透過率の高い無アルカリガラス基板を提供することである。
【構成】本発明の無アルカリガラス基板は、実質的にアルカリ金属酸化物を含まず、質量％で、SnO_2　0．01～0．3％、AS_2O_3　0～0．1％、Sb_2O_3　0～1．0％であり、且つ、ガラス中のFeの含有量が、Fe_2O_3に換算して、質量％で0．005～0．03％であることを特徴とする。
【選択図】　なし

【特許請求の範囲】
【請求項１】
実質的にアルカリ金属酸化物を含まず、質量％で、SnO_2 ０．０１～０．３％、As_2O_3 ０～０．１％、Sb_2O_3 ０～１．０％であり、且つ、ガラス中のＦｅの含有量が、Fe_2O_3に換算して、質量％で０．００５～０．０３％であることを特徴とする無アルカリガラス基板。
【請求項２】
ガラス基板の透過率が、波長３００ｎｍにおいて５０％以上、波長４００～８００ｎｍにおいて８９％以上であることを特徴とする請求項１記載の無アルカリガラス基板。
【請求項３】
質量％で、SiO_2 ５５～７０％、Al_2O_3 １２～２０％、B_2O_3 ５～１５％、ＭｇＯ ０～５％、ＣａＯ ０～１２％、ＳｒＯ ０～１０％、ＢａＯ ０～１０％、ＺｎＯ ０～５％、ZrO_2 ０～５％、Ｃｌ０～０．５％からなることを特徴とする請求項１または２のいずれかに記載の無アルカリガラス基板。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】
本発明は、液晶ディスプレイ、エレクトロルミネッセンスディスプレイ、フィールドエミッションディスプレイ等のフラットパネルディスプレイやセンサー等の基板、固体撮像素子のカバーガラスに用いられる無アルカリガラス基板に関するものである。
【０００２】
【従来の技術】
従来より、フラットパネルディスプレイやセンサー等の基板、固体撮像素子のカバーガラスとしては、矩形状のガラス基板が広く使用されている。
【０００３】
この種のガラス基板の表面には、透明導電膜、絶縁膜、半導体膜、金属膜等が成膜され、しかもフォトリソグラフィーエッチング（フォトエッチング）によって種々の回路やパターンが形成される。これらの成膜、フォトエッチング工程において、ガラス基板は、数百度の熱処理を受けると共に、硫酸、塩酸、アルカリ溶液、フッ酸、バッファードフッ酸等の種々の薬品による処理を受ける。
【０００４】
この種のガラス基板には、以下のような特性が要求される。
（１）ガラス中にアルカリ金属酸化物が含有されていると、熱処理時に成膜された半導体物質中にアルカリイオンが拡散し、膜特性の劣化を招くため、実質的にアルカリ金属酸化物を含有しないこと。
（２）フォトエッチング工程において使用される種々の酸、アルカリ等の薬品によって劣化しないような耐薬品性を有すること。
（３）成膜等のＴＦＴ（薄膜トランジスタ）素子製造工程でガラス基板が熱収縮してパターンずれを起こさないように、高い歪点、具体的には、６４０℃以上の歪点を有すること。例えば多結晶シリコンＴＦＴ－ＬＣＤの場合、その工程温度が６００℃以上であるため、このような用途のガラス基板には、歪点が６４０℃以上であることが要求される。
【０００５】
また、これ以外にも、次のような特性が要求される。
（４）ガラス中に基板として好ましくない溶融欠陥が発生しないよう溶融性に優れていること。
（５）耐熱衝撃性を向上させて、熱処理工程中での破損を低減させるために、熱膨張係数が小さいこと。
【０００６】
更に、これらのデバイスではガラス基板の透過率はきわめて重要であり、紫外域から可視域において、高い透過率を有するガラス基板が望まれている。

【０００７】
例えば、液晶ディスプレイの場合、非発光型ディスプレイであり、光の利用効率が悪いため、可視域におけるガラス基板の透過率は高い方が良い。また、ＴＦＴ（薄膜トランジスタ）素子は、ガラス基板上に透明導電膜、絶縁膜、半導体膜、金属膜等を成膜した後、ガラス基板の裏面より波長３００ｎｍ付近の紫外線を照射する背面露光法によるフォトリソグラフィによって形成される。そのため、紫外域におけるガラス基板の透過率も高い方が良い。
【０００８】
また、近年、注目されている有機エレクトロルミネッセンスディスプレイの場合、赤、緑、青の有機蛍光体を発光させて表示を行うが、青色の光を発する蛍光体の発光効率が他の蛍光体に比べて低い。そのため、青色の光に対応する波長域におけるガラスの透過率は高い方が良い。
【０００９】
【特許文献１】
特開平７－２０２２０８号公報
【特許文献２】
特開２００１－２６１３６６号公報
【００１０】
【発明が解決しようとする課題】
Fe_2O_3は、ガラス中でFe^{3+}又はFe^{2+}の状態で存在し、特に、Fe^{3+}は、３８０ｎｍ付近に吸収ピークを持ち、紫外域、短波長側の可視域における透過率を低下させる。一般に、安価で大量生産されるガラスは、ガラス原料や製造工程中から多量のFe_2O_3がガラス中に混入している。そのため、このようなガラスをディスプレイやセンサーの基板として用いると、紫外域、短波長側の可視域における透過率が低いため、ディスプレイやセンサーとしての性能の低下が懸念されている。
【００１１】
ガラス中へのFe_2O_3の混入を完全に排除するには、高純度ガラス原料を用い、且つ、原料調合設備等から原料へFe_2O_3が混入しないような特別に設計された製造設備を使用する必要があり、製造コストが非常に高くなるため、現実的ではない。
【００１２】
本発明の目的は、上記した要求特性項目（１）～（５）の全てを満足し、しかも、コストを上げることなく、透過率の高い無アルカリガラス基板を提供することである。
【００１３】
【課題を解決するための手段】
本発明者は、種々の実験を繰り返した結果、ガラス中にSnO_2を添加することで所望の透過率が得られることを見いだし本発明として提案するものである。
【００１４】
即ち、本発明の無アルカリガラス基板は、実質的にアルカリ金属酸化物を含まず、質量％で、SnO_2　０．０１～０．３％、As_2O_3　０～０．１％、Sb_2O_3　０～１．０％であり、且つ、ガラス中のＦｅの含有量が、Fe_2O_3に換算して、質量％で０．００５～０．０３％であることを特徴とする。
【００１５】
【作用】
一般に、ガラス基板上のＴＦＴを作製する際に用いられる紫外線は、主として３００ｎｍを中心とした波長の紫外線が使用される。このため、波長３００ｎｍにおけるガラス基板の透過率は、できるだけ高い方が良く、少なくとも５０％以上（好ましくは６０％以上）であることが重要である。この透過率が５０％未満であると背面露光を行ってＴＦＴを形成する際に時間がかかり、生産性に支障をきたす虞がある。
【００１６】
また、液晶ディスプレイは非発光型ディスプレイであるため、光の利用効率の損失は少な

いほうが良い。このため、液晶ディスプレイ用ガラス基板の可視域における透過率はできるだけ高い方が良く、波長４００～８００ｎｍにおける透過率は８９％以上（好ましくは９０％以上）であることが重要である。この透過率が８９％未満であるとディスプレイの性能が低下する虞がある。

【００１７】

そこで、本発明の無アルカリガラス基板においては、ガラス中のAs_2O_3を０．１％以下に制限し、SnO_2を０．０１～０．３％添加する。これによりＦｅの価数を３価（Fe^{3+}）から２価（Fe^{2+}）へ変化させて波長３００ｎｍにおける透過率を５０％以上に保ち、且つ、波長４００～８００ｎｍにおける透過率を８９％以上にしている。

【００１８】

ガラス中にSnO_2を０．０１～０．３％含有させると、$Sn^{2+} + 2Fe^{3+} \uparrow Sn^{4+} + 2Fe^{2+}$の反応が起こり、Ｆｅの価数が変化して、$Fe^{2+}$が増加し、$Fe^{3+}$が減少すると考えられ、紫外域や短波長側の可視域の透過率が上昇する。SnO_2の含有量が０．０１％より少ないと、価数変化するＦｅの量が少なくなり、紫外域や短波長側の可視域の透過率が低くなるため好ましくない。一方、０．３％より多いとSnO_2の結晶が析出しやすくなるため好ましくない。SnO_2の好ましい範囲は０．０５～０．３％である。尚、Ｓｎと同様にＦｅの価数変化を起こすものとして、ＣｅやＴｉ等が存在するが、これらは、紫外域に吸収を持つため、好ましくない。

【００１９】

また、清澄剤として広く使用されているAs_2O_3は紫外域に吸収ピークを持つ。更に、SnO_2によるFe^{2+}への価数変化を阻害する働きがある。このため、As_2O_3の含有量は０．１％以下に制限される。As_2O_3の含有量が０．１％より多いと、紫外域の透過率が低下するため好ましくない。好ましくは０．０５％以下である。尚、無アルカリガラスにおいて、清澄剤として用いられているAs_2O_3の含有量を減らすと、泡のないガラスを得ることは難しくなるが、透過率を高めるために添加しているSnO_2が清澄剤としても働くため、Sb_2O_3やＣｌを適宜組み合せることで泡のないガラスを得ることができる。但し、Sb_2O_3もAs_2O_3と同様に紫外域に吸収ピークを持つため、その含有量は１．０％以下に抑えるべきである。

【００２０】

また、SnO_2の添加によって、Fe^{2+}が増加しすぎると、Fe^{2+}は１０８０ｎｍ付近に吸収ピークを持つため、長波長側の可視透過率が低下し、波長４００～８００ｎｍにおける透過率を８９％以上に保つことができなくなる虞がある。これを防止するには、全Ｆｅ量を調整する必要があり、Fe_2O_3に換算して０．００５～０．０３％の範囲内に入るようにすることが重要である。Fe_2O_3の含有量が０．０３％より多くなると、長波長側の可視透過率が低下するため好ましくない。一方、０．００５％より少なくしようとすると、コストが高くなりすぎるため好ましくない。Fe_2O_3の好ましい範囲は、０．００７～０．０３％である。

【００２１】

本発明において使用するガラスは無アルカリガラスである。その理由は、ガラス中にアルカリ金属酸化物（Na_2O、K_2O、Li_2O）を含有すると、ガラス中のアルカリ成分が、ガラス基板上に形成された各種の膜やＴＦＴ素子の特性を劣化させるばかりか、アルカリ成分と各種の膜が反応することで白濁し、基板の透過率を低下させる虞があるからである。

【００２２】

また、本発明のガラス基板の具体的な組成は、耐薬品性、熱収縮性、溶融性、成形性、熱膨張係数等を考慮して、用途に応じて適宜決定すればよい。好適な組成例として、質量百分率で、SiO_2　５５～７０％、Al_2O_3　１２～２０％、B_2O_3　５～１５％、ＭｇＯ　０～５％、ＣａＯ　０～１２％、ＳｒＯ　０～１０％、ＢａＯ　０～１０％、ＺｎＯ　０～５％、ZrO_2　０～５％、Ｃｌ　０～０．５％の無アルカリガラスがあげられる。

【００２３】
このようにガラス組成を限定した理由は、次のとおりである。
【００２４】
SiO_2は、ガラスのネットワークフォーマーとなる成分であり、ガラスの耐酸性を向上させたり、ガラスの歪点を上昇させてガラス基板の熱収縮を小さくする効果がある。含有量が５５～７０％であれば、耐酸性が高く、熱収縮の小さいガラス基板を得ることができる。好ましい範囲は、５７～６７％である。尚、SiO_2の含有量が多くなると、ガラスの高温粘度が高くなり、溶融性が悪化すると共にクリストバライトの失透ブツが析出しやすくなる傾向にある。また、含有量が少なくなると、ガラスの耐酸性や歪点が低下する傾向にある。
【００２５】
Al_2O_3は、ガラスの歪点を上昇させたり、クリストバライトの失透ブツの析出を抑える成分である。含有量が１２～２０％であれば、液相温度が低いガラス基板を得ることができる。好ましい範囲は、１３～１８％である。尚、Al_2O_3の含有量が多くなると、ガラスの耐バッファードフッ酸性が悪化したり、液相温度が上昇して成形しにくくなる傾向にある。また、含有量が少なくなると、ガラスの歪点が低下する傾向にある。
【００２６】
B_2O_3は、融剤として作用し、ガラスの粘性を下げ、溶融性を改善する成分である。含有量が５～１５％であれば、上記効果を得ることができる。好ましい範囲は、７～１４％である。尚、B_2O_3の含有量が多くなると、ガラスの歪点が低下したり、耐酸性が悪化する傾向にある。また、含有量が少なくなると、融剤として十分に作用せず溶融性が低下する傾向にある。
【００２７】
ＭｇＯは、ガラスの歪点を低下させずに高温粘性のみを低下させて、ガラスの溶融性を改善する成分である。含有量が５％以下であれば、ガラスの溶融性を改善することができる。好ましい範囲は、０～３％である。尚、ＭｇＯの含有量が多くなると、エンステタイトの失透ブツが析出しやすくなる。また、耐バッファードフッ酸性が低下し、フォトエッチング工程において、ガラス基板表面が侵食されて、反応性生物がガラス基板表面に付着し、ガラス基板が白濁し易くなる。
【００２８】
ＣａＯは、ガラスの歪点を低下させずに高温粘性のみを低下させて、ガラスの溶融性を著しく改善する成分である。含有量が１２％以下であれば、ガラスの溶融性を改善することができる。好ましい範囲は、３～１０％である。尚、ＣａＯの含有量が多くなると、耐バッファードフッ酸性が悪化する傾向にある。
【００２９】
ＳｒＯは、ガラスの耐薬品性と耐失透性を向上させる成分である。含有量が１０％以下であれば、上記効果を得ることができる。好ましい範囲は０～７％である。尚、ＳｒＯの含有量が多くなると、ガラスの密度や熱膨張係数が大きくなったり、溶融性が悪化する傾向にある。
【００３０】
ＢａＯは、ＳｒＯと同様にガラスの耐薬品性と耐失透性を向上させる成分である。含有量が１０％以下であれば、上記効果を得ることができる。好ましい範囲は０～５％である。尚、ＢａＯの含有量が多くなると、ガラスの密度や熱膨張係数が大きくなったり、溶融性が著しく悪化する傾向にある。
【００３１】
ＺｎＯは、ガラスの耐バッファードフッ酸性や溶融性を改善する成分である。含有量が３％以下であれば、上記効果を得ることができる。好ましい範囲は、０～２．５％である。尚、ＺｎＯの含有量が多くなると、ガラスの耐失透性や歪点が低下する傾向にある。
【００３２】
尚、ＭｇＯ、ＣａＯ、ＳｒＯ、ＢａＯのアルカリ土類金属酸化物は、混合して含有させる

ことで、ガラスの溶融性と耐失透性を向上させることができるが、これら成分の合量が多くなると、ガラスの密度が上昇する傾向にあり、ガラス基板の軽量化が困難となるため、合量で１１％未満にすることが望ましい。

【００３３】

ＳｒＯ$_2$は、ガラスの耐酸性を改善する成分である。含有量が１％以下であれば、ガラスの耐酸性を向上させることができる。好ましい範囲は、０～０．７％である。尚、ＳｒＯ$_2$の含有量が多くなると、ジルコンの失透ブツが析出する傾向にある。

【００３４】

Ｃｌは、ガラスの清澄剤として働く成分である。含有量が多くなると、ガラス融液からの揮発が多くなり、脈理が発生しやすくなるが、含有量が０．５％以下であれば、問題なく上記効果が得られる。好ましい範囲は、０～０．４％である。

【００３５】

次に、本発明の無アルカリガラス基板を製造する方法を説明する。

【００３６】

まず、不純物として含まれるＦｅの量を考慮しながら、無アルカリガラスの原料を選択し、その原料を用いて上記のガラス組成範囲となるように調合する。続いて、調合した原料を連続溶融炉で１５２０～１６８０℃の温度で溶融する。その後、溶融ガラスをスロットダウンドロー法、オーバーフローダウンドロー法、フロート法、ロールアウト法等の方法で板状に成形し徐冷することで無アルカリガラス基板を得ることができる。

【００３７】

【実施例】

以下、本発明を実施例に基づいて詳細に説明する。

【００３８】

表１～４は、本発明の実施例（試料Ｎｏ．１～２０）を、表５は、比較例（試料Ｎｏ．２１、２２）をそれぞれ示している。

【００３９】

【表１】

	実施例				
	1	2	3	4	5
組成（質量%）					
SiO_2	63.0	63.0	63.0	63.0	63.0
Al_2O_3	16.0	16.0	16.0	16.0	16.0
B_2O_3	11.0	11.0	11.0	11.0	10.0
MgO	—	—	—	—	—
CaO	7.0	7.0	7.0	7.0	8.0
SrO	1.5	1.5	1.5	1.5	1.0
BaO	0.5	0.5	0.5	0.5	1.0
ZnO	—	—	—	—	—
ZrO_2	—	—	—	—	—
SnO_2	0.1	0.1	0.1	0.1	0.1
As_2O_3	—	—	—	—	—
Sb_2O_3	0.9	0.9	0.9	0.9	0.9
Cl	—	—	—	—	—
全Fe_2O_3	0.008	0.010	0.012	0.015	0.020
透過率（%） 300nm	74	71	69	66	60
400nm	92	91	91	91	90
600nm	92	91	91	91	90
800nm	92	92	92	92	91
密度（g/cm^3）	2.38	2.38	2.38	2.38	2.40
熱膨張係数[30-380℃]（$\times 10^{-7}$／℃）	32	32	32	32	33
歪点（℃）	675	675	675	675	676
$\log\eta$ at $10^{2.5}$（℃）	1610	1610	1610	1610	1595
液相温度（℃）	1095	1095	1095	1095	1105
耐酸性	○	○	○	○	○
耐バッファードフッ酸性	○	○	○	○	○

【００４０】
【表２】

	実施例				
	6	7	8	9	10
組成（質量%）					
SiO_2	63.0	63.0	63.0	63.0	64.0
Al_2O_3	16.0	16.0	16.0	16.0	16.0
B_2O_3	10.0	12.0	12.0	12.0	11.0
MgO	—	—	—	—	—
CaO	8.0	8.0	8.0	8.0	8.0
SrO	1.0	—	—	—	0.5
BaO	1.0	—	—	—	0.1
ZnO	—	—	—	—	—
ZrO_2	—	—	—	—	—
SnO_2	0.1	0.2	0.05	0.15	0.2
As_2O_3	—	—	—	—	—
Sb_2O_3	0.9	0.8	0.9	0.75	—
Cl	—	—	0.05	0.1	0.2
全Fe_2O_3	0.025	0.015	0.015	0.020	0.020
透過率（%） 300nm	55	72	61	63	67
400nm	90	91	91	91	91
600nm	91	92	91	91	92
800nm	91	92	92	92	92
密度（g/cm^3）	2.40	2.35	2.35	2.35	2.37
熱膨張係数[30-380℃]（$\times 10^{-7}$／℃）	33	31	31	31	32
歪点（℃）	676	670	668	671	670
$\log\eta$ at $10^{2.5}$（℃）	1595	1590	1590	1595	1600
液相温度（℃）	1105	1080	1080	1080	1110
耐酸性	○	○	○	○	○
耐バッファードフッ酸性	○	○	○	○	○

【0041】
【表8】

	実施例				
	11	12	13	14	15
組成（質量%）					
SiO_2	61.0	62.0	63.0	62.0	62.0
Al_2O_3	16.0	15.0	16.0	16.0	16.0
B_2O_3	12.0	9.4	12.0	11.0	11.0
MgO	—	0.5	—	—	1.3
CaO	7.0	7.0	7.0	8.0	8.0
SrO	1.9	4.0	1.0	0.5	1.0
BaO	1.0	0.05	0.3	1.5	0.5
ZnO	0.5	0.5	—	0.5	—
ZrO_2	—	0.4	—	0.15	—
SnO_2	0.1	0.25	0.15	0.15	0.1
As_2O_3	—	0.1	—	—	—
Sb_2O_3	0.5	0.7	0.5	—	0.1
Cl	—	0.1	0.05	0.2	—
全Fe_2O_3	0.015	0.015	0.015	0.010	0.010
透過率（%） 300nm	65	72	70	74	70
400nm	91	91	91	92	91
600nm	92	92	92	92	92
800nm	92	92	92	92	92
密度（g/cm^3）	2.40	2.44	2.35	2.40	2.39
熱膨張係数[30-380℃]（$\times 10^{-7}$／℃）	34	33	31	33	34
歪点（℃）	665	671	668	669	673
$\log\eta$ at $10^{2.5}$（℃）	1555	1560	1605	1565	1560
液相温度（℃）	1105	1055	1090	1085	1120
耐酸性	○	○	○	○	○
耐バッファードフッ酸性	○	○	○	○	○

【００４２】
【表４】

	実施例				
	16	17	18	19	20
組成（質量%）					
SiO_2	63.0	59.5	62.0	61.1	64.0
Al_2O_3	16.0	18.0	17.0	17.5	15.5
B_2O_3	9.5	10.5	10.0	9.5	9.0
MgO	—	—	0.3	—	0.7
CaO	9.0	8.0	8.5	5.5	6.5
SrO	1.0	—	0.5	3.5	2.0
BaO	0.5	3.0	1.5	0.5	—
ZnO	0.5	0.5	—	1.0	1.0
ZrO_2	—	0.2	—	0.3	0.5
SnO_2	0.15	0.15	0.15	0.1	0.1
As_2O_3	—	—	—	—	—
Sb_2O_3	0.25	0.15	—	0.9	0.4
Cl	0.1	—	0.05	0.1	0.3
全Fe_2O_3	0.010	0.010	0.01	0.015	0.015
透過率（%） 300nm	72	71	71	66	65
400nm	91	91	91	91	91
600nm	92	92	92	91	91
800nm	92	92	92	92	92
密度（g/cm^3）	2.42	2.43	2.40	2.43	2.41
熱膨張係数[30-380℃]（$\times 10^{-7}$／℃）	34	34	33	31	30
歪点（℃）	677	680	682	686	685
$\log\eta$ at $10^{2.5}$（℃）	1585	1520	1585	1560	1605
液相温度（℃）	1095	1115	1100	1115	1045
耐酸性	○	○	○	○	○
耐バッファードフッ酸性	○	○	○	○	○

【0048】
【表5】

	比較例	
	21	22
組成（質量%）		
SiO_2	62.0	58.5
Al_2O_3	16.0	15.0
B_2O_3	11.0	10.0
MgO	4.0	1.0
CaO	4.0	5.0
SrO	1.0	6.0
BaO	−	1.4
ZnO	−	−
ZrO_2	−	1.5
SnO_2	−	0.05
As_2O_3	−	1.0
Sb_2O_3	2.0	0.5
Cl	−	0.05
全Fe_2O_3	0.020	0.030
透過率（%） 300nm	40	39
400nm	90	89
600nm	90	89
800nm	91	90
密度（g/cm^3）	2.38	2.49
熱膨張係数[30-380℃]（$\times 10^{-7}$／℃）	30	37
歪点（℃）	675	670
$\log\eta$ at $10^{2.5}$（℃）	1570	1460
液相温度（℃）	1090	1230
耐酸性	○	○
耐バッファードフッ酸性	×	○

【００４４】
表中の各試料は、次のようにして作製した。
【００４５】
まず表の組成となるようにガラス原料を調合し、白金ポットで１６００℃で２４時間溶融した後、カーボン板上に流し出し、板状に成形した。次いでこれらの板状ガラスの両面を光学研磨することによって、縦寸法が３００ｍｍ、横寸法が３００ｍｍ、厚みが０．７ｍｍの大型で薄肉のガラス基板を作製した。
【００４６】
このようにして作製した各試料について、各種の特性を評価した。結果を表に示す。
【００４７】
表から明らかなように、実施例である試料Ｎｏ．１～２０はいずれも波長３００ｎｍにおける透過率が５５％以上と高く、波長４００～８００ｎｍにおける透過率も９０％以上と

高かった。密度は２．４３ｇ／ｃｍ$_3$以下と低く、基板の軽量化を図ることができる。熱膨張係数は３０～３４×１０$^{-7}$／℃であった。歪点は６６５℃以上と高いため、熱収縮の小さいガラス基板が得られる。また、１０$^{2.5}$ポイズに相当する温度は１６１０℃以下、液相温度は、１１２０℃以下であるため、溶融性、成形性にも優れていた。更に、耐酸性、耐ＢＨＦにも優れていた。

【００４８】

一方、比較例である試料Ｎｏ．２１及び２２は、波長３００ｎｍにおける透過率が４０％以下と低かった。

【００４９】

透過率については、分光光度計にて波長３００ｎｍ、４００ｎｍ、６００ｎｍ、８００ｎｍにおける試料の透過率を測定した。

【００５０】

密度については、周知のアルキメデス法によって測定した。

【００５１】

熱膨張係数は、ディラトメーターを用いて、３０～３８０℃における平均熱膨張係数を測定したものである。

【００５２】

歪点は、ＡＳＴＭ Ｃ３３６－７１の方法に基づいて測定し、この値が高いほど、ガラスの熱収縮は小さくなる。ｌｏｇη αｔ １０$^{2.5}$は、高温粘度である１０$^{2.5}$ポイズの粘度に相当する温度を示すものであり、この温度が低いほど、溶融性に優れていることになる。

【００５３】

液相温度については、以下の要領で行った。まず、各試料をそれぞれ３００～５００μｍの大きさに粉砕、洗浄し、これを白金製のボートに入れて１０００～１３００℃の温度勾配炉に移して２４時間保持し、温度勾配炉より白金製のボートを取り出した。その後、白金製のボートからガラスを取り出した。このようにして得られたサンプルを偏光顕微鏡で観察し、結晶の析出点を測定し、これを液相温度とした。

【００５４】

耐ＨＣｌ性は、各試料を８０℃に保持された１０質量％塩酸水溶液に３時間浸漬した後、それらの表面状態を目視で観察することによって評価した。また、耐バッファードフッ酸性は、各試料を２０℃に保持された３０質量％弗化アンモニウム、６質量％フッ酸からなるバッファードフッ酸に３０分間浸漬した後、それらの表面状態を目視で観察することによって評価した。ガラス基板の表面に全く変化のないものは○、変色したものは×で示した。

【００５５】

【発明の効果】

以上のように、本発明の無アルカリガラス基板は、可視域全体に亘って透過率が高いため、フラットパネルディスプレイやセンサー等の基板、固体撮像素子のカバーガラスに用いられるガラス基板として好適である。また、紫外域における透過率も高いため、特に、背面露光によってＴＦＴ素子を製作するＴＦＴ型アクティブマトリックス液晶ディスプレイに使用される無アルカリガラス基板として好適である。

フロントページの続き

(51)Int.Cl.[7]	FI	テーマコード（参考）
H05B 33/14	H05B 33/14 A	

Fターム(参考) 4G062 AA01 BB05 BB06 DA06 DA07 DB04 DC03 DC04 DD01 DE01
DE02 DE03 DF01 EA01 EB01 EC01 ED01 ED02 ED03 EE01
EE02 EE03 EF01 EF02 EF03 EG01 EG02 EG03 FA01 FB01
FC01 FC02 FC03 FD01 FE01 FF01 FG01 FH01 FJ01 FK01
FL01 GA01 GA10 GB01 GC01 GD01 GE01 HH01 HH03 HH05
HH07 HH09 HH11 HH13 HH15 HH17 HH20 JJ01 JJ03 JJ05
JJ06 JJ07 JJ10 KK01 KK03 KK05 KK07 KK10 MM05 MM23
MM27 NN32 NN34

(12)特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
国際事務局

(43) 国際公開日
2004年10月14日 (14.10.2004)

PCT

(10) 国際公開番号
WO 2004/087597 A1

(51) 国際特許分類[7]: C03C 3/091, 3/078, 3/083, 3/085, 3/087, 3/089

(21) 国際出願番号: PCT/JP2004/004626

(22) 国際出願日: 2004年3月31日 (31.03.2004)

(25) 国際出願の言語: 日本語

(26) 国際公開の言語: 日本語

(30) 優先権データ:
特願2003-094993 2003年3月31日 (31.03.2003) JP

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(81) 指定国 (表示のない限り、全ての種類の国内保護が可能): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) 指定国 (表示のない限り、全ての種類の広域保護が可能): ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), ユーラシア (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), ヨーロッパ (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

添付公開書類:
— 国際調査報告書

２文字コード及び他の略語については、定期発行される各PCTガゼットの巻頭に掲載されている「コードと略語のガイダンスノート」を参照。

WO 2004/087597 A1

(54) Title: ALKALI-FREE GLASS

(54) 発明の名称: 無アルカリガラス

(57) Abstract: An alkali-free glass, characterized in that it exhibits a ratio ($\Delta_{an\text{-}st}$)/($\alpha_{50\text{-}350}$) of the gradient $\Delta_{an\text{-}st}$ (ppm/°C) of an equilibrium density curve in a temperature region from around an annealing point (T_{an}) to around a strain point (T_{st}) to the average coefficient of linear expansion $\alpha_{50\text{-}350}$(X 10^{-6}/°C) in a temperature range of 50 to 350°C of 0 or more and less than 3.64. The alkali-free glass allows the reduction of the compaction caused by a heating treatment without the significant enhancement of a strain point.

(57) 要約: 歪点を顕著に高くすることなく、加熱処理の際に発生するコンパクションを低減することができる無アルカリガラスを提供する。 徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域における平衡密度曲線の勾配$\Delta_{an\text{-}st}$（ｐｐｍ／℃）と、５０～３５０℃における平均線膨張係数$\alpha_{50\text{-}350}$（×１０−６／℃）と、の比（$\Delta_{an\text{-}st}$／$\alpha_{50\text{-}350}$）が、０以上３．６４未満であることを特徴とする無アルカリガラス。

明 細 書

無アルカリガラス

技術分野

本発明は、液晶ディスプレイ等のディスプレイ用基板、フォトマスク用基板に好適な無アルカリガラスに関する。

背景技術

従来、ディスプレイ用基板、特にその表面に電極や薄膜トランジスタ（ＴＦＴ）等を形成するために、金属または酸化物の薄膜が形成されるディスプレイ用基板に使用されるガラスは、アルカリ金属酸化物を実質的に含有しない無アルカリガラスであることが求められている。このようなディスプレイ用基板に好適な無アルカリガラスが、特開平８－１０９０３７号公報、特開平９－１６９５３９号公報、特開平１０－７２２３７号公報、特表２００１－５０６２２３号公報、特開２００２－２９７７５号公報および特表２００３－５０３３０１号公報に開示されている。

ディスプレイ用基板に使用されるガラスは、無アルカリガラスであることに加えて、（１）薄膜形成工程における加熱によるガラス基板の変形、特に熱収縮（コンパクション）が少ないこと、（２）ガラス基板上に形成されたSiO_xやSiN_xのエッチングに用いられるバッファードフッ酸（フッ酸とフッ化アンモニウムの混合液）に対する耐久性（耐ＢＨＦ性）が高いこと、（３）ガラス基板上に形成された金属電極またはＩＴＯ（スズがドープされたインジウム酸化物）のエッチングに用いられる硝酸、硫酸、塩酸、等のエッチングに対する耐久性（耐酸性）が高いこと、（４）アルカリ性のレジスト剥離液に対する充分な耐久性を有すること、（５）ディスプレイの軽量化のために比重（密度）が小さいこと、（６）ディスプレイ製造工程における昇降温速度を大きくし、また耐熱衝撃性を向上させるために膨張係数が小さいこと、（７）失透しにくいこと等、が求められる。

これらディスプレイ用基板に使用される無アルカリガラスに求められる特性のうち、薄膜形成行程における加熱によるガラス基板の変形および／またはコンパクションの低減に関して、特開平８－１０９０３７号公報、特開平９－１６９５３９号公報、特開平１０

－７２２３７号公報、特表２００１－５０６２２３号公報、特開２００２－２９７７５号公報および特表２００３－５０３３０１号公報に記載の無アルカリガラスを含めて、従来の無アルカリガラスでは、ガラスの歪点を高くすることで対応している。しかしながら、歪点を高くすると、溶解、成形といったガラスの製造プロセスをより高温で実施することが必要となる。これはすなわち、溶融炉のようなガラス製造プロセスで使用する設備をより高温での使用に耐えうるものにすることが必要となり、また、設備の寿命が短かくなるので好ましくない。

液晶ディスプレイの駆動回路としてガラス基板上に形成される薄膜トランジスタ（ＴＦＴ）は、アモルファスシリコン膜から製造されるＴＦＴ（ａ－Ｓｉ　ＴＦＴ）から、低温プロセスを用いて多結晶シリコン膜から製造させるＴＦＴ（ｐ－Ｓｉ　ＴＦＴ）へと移行が進んでいる。しかしながら、ａ－Ｓｉ　ＴＦＴに比べて、ｐ－Ｓｉ　ＴＦＴでは、薄膜形成行程をより高温で実施することが必要である。これは、ガラス基板の歪点をさらに高くすることが必要であることを意味し、製造プロセスはさらに高温で実施することが必要となる。また、ｐ－ＴＦＴへの移行の主な理由の１つは、ディスプレイの高精細化および高性能化であり、ディスプレイ用基板にはより高い表面精度が求められる。このこともまた、コンパクションの低減が求められる理由である。

発明の開示

本発明は、上記した従来技術の問題点を解決するため、歪点を顕著に高くすることなしに、ディスプレイ基板として使用する際の薄膜形成行程のような、加熱処理の際に発生するコンパクションを低減することができる無アルカリガラスを提供することを第１の目的とする。

また、本発明は、下記特性をも有する無アルカリガラスを提供することを第２の目的とする。

・耐ＢＨＦ性が高い。

・耐酸性が高い。

・アルカリ性のレジスト剥離液に対する充分な耐久性を有する。

・比重（密度）が小さい。

・膨張係数が小さい。

・失透しにくい。

上記目的を達成するため、本発明は、徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域における平衡密度曲線の勾配Δ_{an-st}（ｐｐｍ／℃）と、５０～３５０℃における平均線膨張係数α_{50-350}（×１０$^{-6}$／℃）と、の比（Δ_{an-st}／α_{50-350}）が、０以上３．６４未満であることを特徴とする無アルカリガラスを提供する。

また、本発明は、主として以下の構成要素よりなる無アルカリガラスを提供する。

６８％≦SiO_2≦８０％

０％≦Al_2O_3＜１２％

０％＜B_2O_3＜７％

０％≦ＭｇＯ≦１２％

０％≦ＣａＯ≦１５％

０％≦ＳｒＯ≦４％

０％≦ＢａＯ≦１％

５％≦ＲＯ≦１８％

ここで、％は上記構成要素の合計を１００％とした場合のモル％であり、ＲＯはＭｇＯ＋ＣａＯ＋ＳｒＯ＋ＢａＯを表している。

さらにまた、本発明は、主として以下の構成要素よりなり、徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域における平衡密度曲線の勾配Δ_{an-st}（ｐｐｍ／℃）と、５０～３５０℃における平均線膨張係数α_{50-350}（×１０$^{-6}$／℃）と、の比（Δ_{an-st}／α_{50-350}）が、０以上３．６４未満であることを特徴とする無アルカリガラスを提供する。

６８％≦SiO_2≦８０％

０％≦Al_2O_3＜１２％

０％＜B_2O_3＜７％

０％≦ＭｇＯ≦１２％

０％≦ＣａＯ≦１５％

０％≦ＳｒＯ≦４％

０％≦ＢａＯ≦１％

５％≦ＲＯ≦１８％

ここで、％は上記構成要素の合計を１００％とした場合のモル％であり、ＲＯはＭｇＯ＋ＣａＯ＋ＳｒＯ＋ＢａＯを表している。

本発明の無アルカリガラスにおいて、前記（Δ_{an-st}／α_{50-350}）は0以上３．５以下であることが好ましい。

本発明の無アルカリガラスにおいて、前記SiO_2の含有割合が６８％≦SiO_2≦７５％であることが好ましい。

本発明の無アルカリガラスにおいて、前記Al_2O_3の含有割合が５％≦Al_2O_3≦１１．５％であることが好ましい。

本発明の無アルカリガラスにおいて、前記B_2O_3の含有割合が２％≦B_2O_3＜７％であることが好ましい。

本発明の無アルカリガラスにおいて、前記ＭｇＯの含有割合が３％≦ＭｇＯ≦１０％であることが好ましい。

本発明の無アルカリガラスにおいて、前記ＣａＯの含有割合が０．５％≦ＣａＯ≦１２％であることが好ましい。

本発明の無アルカリガラスにおいて、前記ＲＯの割合が５．５％≦ＲＯ≦１８％であることが好ましい。

本発明の無アルカリガラスにおいて、液相温度における粘度η_Lが、$10^{3.8}$ ｄＰａ・ｓ以上であることが好ましい。

さらにまた、本発明は、主として以下の構成要素よりなり、徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域における平衡密度曲線の勾配Δ_{an-st}（ｐｐｍ／℃）と、５０～３５０℃における平均線膨張係数α_{50-350}（×10^{-6}／℃）と、の比（Δ_{an-st}／α_{50-350}）が、0以上３．５以下であり、

液相温度における粘度η_Lが、$10^{3.8}$ ｄＰａ・ｓ以上であることを特徴とする無アルカリガラスを提供する。

６８％≦SiO_2≦７２．５％

８％≦Al_2O_3≦１０．５％

4．５％≦B_2O_3＜７％

３％≦ＭｇＯ≦１０％

2．５％≦ＣａＯ≦７％

０％≦ＳｒＯ≦４％

０％≦ＢａＯ≦１％

5．５％≦ＲＯ≦１８％

ここで、％は上記構成要素の合計を１００％とした場合のモル％であり、ＲＯはＭｇＯ＋ＣａＯ＋ＳｒＯ＋ＢａＯを表している。

発明を実施するための最良の形態

本発明の無アルカリガラス（以下本発明のガラスという。）は実質的にアルカリ金属酸化物を含有しない。具体的には、アルカリ金属酸化物の含有量の合計が、好ましくは０．５モル％以下である。

本発明のガラスは、徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域における平衡密度曲線の勾配Δ_{an-st}（ｐｐｍ／℃）と、５０～３５０℃における平均線膨張係数α_{50-350}（×10^{-6}／℃）と、の比（Δ_{an-st}／α_{50-350}）が、０以上３．６４未満であることを特徴とする。

コンパクション（ｃｏｍｐａｃｔｉｏｎ）とは、加熱処理の際に、ガラス構造の緩和によって発生するガラスの熱収縮である。コンパクションは、密度変化から下記式で導くことができる。

$C=(1-(d_0/d)^{1/3})\times 10^6$

Ｃ　：コンパクション（ｐｐｍ）

d_0：加熱処理前のガラス密度（ｇ／cm^3）

ｄ　：加熱処理後のガラス密度（ｇ／cm^3）

ここから、ガラスの温度変化による密度変化を小さくすれば、コンパクションを低減できることになる。

本発明者らは、鋭意検討した結果、徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域におけるガラスの平衡密度曲線の勾配Δ_{an-st}（ｐｐｍ／℃）と、５０～３５０℃

における平均線膨張係数α_{50-350}（$\times 10^{-6}$／℃）と、の比（Δ_{an-st}／α_{50-350}）をある特定の値よりも小さくすれば、歪点を顕著に高くすることなしに、加熱処理の際に生じるコンパクションを低減できることを見いだした。

なお、徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域において、平衡密度曲線はほぼ直線に近似することができる。従って、本発明において、Δ_{an-st}はこの直線の傾きを意味する。

本発明のガラスは、徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域における平衡密度曲線の勾配Δ_{an-st}（ｐｐｍ／℃）と、５０～３５０℃における平均線膨張係数α_{50-350}（$\times 10^{-6}$／℃）と、の比（Δ_{an-st}／α_{50-350}）が、０以上３．６４未満であることにより、加熱処理の際に生じるコンパクションが低減される。具体的には、例えば、後述する実施例で用いた下記手順で求められるコンパクションが１９０ｐｐｍ未満である。

コンパクジョンの特定

溶融ガラスを板状に成形した後、徐冷点付近の温度で１時間保持してから降温速度１℃／分で室温まで徐冷する。得られたガラスを、所定の形状に加工した後、９００℃まで加熱し、該温度で１分間保持した後、降温速度１００℃／分で室温まで冷却して試料Ａを得る。次に、試料Ａをガラスの粘度が１７．８ｄＰａ・ｓとなる温度（理論値）まで昇温速度１００℃／時で加熱し、該温度で８時間保持した後、降温速度１００℃／時で徐冷して試料Ｂを得る。得られる試料Ａ、Ｂの密度（ｄＡ、ｄＢ）を重液法で決定する。コンパクションＣ（ｐｐｍ）は、このようにして得られる密度（ｄＡ、ｄＢ）と下記式を用いて算出することができる。

$C=(1-(dA/dB)^{1/3})\times 10^{6}$

重液法とは、ブロモホルムとペンタクロロエタンをガラスの密度とほぼ等しくなるように混合した液を用い、これを入れたガラスビンを温度勾配を持たせた水槽に入れ、ガラス試料がとどまる位置を測定することによりガラスの密度を測定する方法である。アルキメデス法で予め測定し、密度値既知の標準サンプルと比較することで対象となるガラスの密度値を決定する。

ガラスの粘度が１７．８ｄＰａ・ｓとなる温度（理論値）は、徐冷点（粘度：１３．０

ｄＰａ・ｓ）および歪点（粘度：１４．５ｄＰａ・ｓ）を用いて、横軸を１０００／Ｔ（Ｋ）、縦軸を粘度（ｄＰａ・ｓ）としてアレニウスプロットにて得ることができる。

Δ_{an-st} ／α_{50-350}は、好ましくは３．５０以下である。Δ_{an-st} ／α_{50-350}が３．５０以下であると、上記手順で求められるコンパクションが１８０ｐｐｍ以下にもなりうる。上記手順で求められるコンパクションが１８０ｐｐｍ以下であれば、歪点を顕著に高くすることなしに、加熱処理の際に発生するコンパクションが十分に低減されることになる。歪点が上昇すると、ガラス溶解粘性が上昇し、溶融炉等、ガラスの製造プロセスに使用する設備をより高温での使用に耐えうるものへと変更することが必要になるが、本発明のガラスは、この問題が解消されている。

Δ_{an-st} ／α_{50-350}は、より好ましくは３．４０以下であり、さらに好ましくは３．２０以下であり、さらに好ましくは３．００以下であり、２．８０以下であることが特に好ましい。

本発明のガラスは、Δ_{an-st} ／α_{50-350}が０以上３．６４未満になるように、ガラスの構成成分、具体的には下記７成分の組成比を選択することで好適に製造することができる。

無アルカリガラスは、主として以下の７成分で構成される。

SiO_2，Al_2O_3，B_2O_3

ＭｇＯ，ＣａＯ，ＳｒＯ，ＢａＯ

上段に記載した３成分は、主としてガラスを形成する成分であり、下段に記載した４成分は、ガラスを溶かすための融剤成分である。

本発明者らは、ガラスにおける上記７成分の含有割合を変えて実験を行い、上記７成分と、Δ_{an-st} ／α_{50-350}と、の間には、以下の関係があることを見いだした。

Δ_{an-st} ／α_{50-350}　小　SiO_2 ＜Al_2O_3 ＜B_2O_3　大

小　ＭｇＯ＜ＣａＯ＜ＳｒＯ　大

さらに、物性を考慮すると以下の関係が成り立つことが推定される。

小　ＭｇＯ＜ＣａＯ＜ＳｒＯ＜ＢａＯ　大

本発明者らは、Δ_{an-st} ／α_{50-350}が０以上３．６４未満になることに加えて、ディスプレイ基板に使用される無アルカリガラスに要求される他の特性、例えば耐ＢＨＦ性、耐酸性、アルカリ性のレジスト剥離液に対する耐久性、耐衝撃性、失透しにくさ等の観点か

らも検討し、以下に示す本発明の無アルカリガラスの好適組成を見いだした。

$68\% \leqq SiO_2 \leqq 80\%$

$0\% \leqq Al_2O_3 < 12\%$

$0\% < B_2O_3 < 7\%$

$0\% \leqq MgO \leqq 12\%$

$0\% \leqq CaO \leqq 15\%$

$0\% \leqq SrO \leqq 4\%$

$0\% \leqq BaO \leqq 1\%$

$5\% \leqq RO \leqq 18\%$

ここで、%は上記構成要素の合計を100%とした場合のモル%であり、ROはMgO+CaO+SrO+BaOを表している。

次に本発明のガラスの組成について、モル%を単に%と表記して説明する。

SiO_2 はネットワークフォーマであり、必須である。上記したように、SiO_2 は、ガラスを形成する3成分（SiO_2、Al_2O_3、B_2O_3）中、$\Delta_{an-st}/\alpha_{50-350}$ を最も小さくする。そのため、本発明のガラスは、SiO_2 の含有割合が高いことが好ましい。具体的には、本発明のガラスは、SiO_2 の含有割合が68%以上80%以下である。SiO_2 の含有割合が80%超ではガラスの溶解性が低下し、また失透しやすくなる。SiO_2 の含有割合は好ましくは75%以下、より好ましくは74%以下、さらに好ましくは73%以下、さらに好ましくは72．5%以下であり、特に好ましくは72%以下である。SiO_2 の含有割合が72．5%以下であると、ガラスの成形性および失透温度の低減に特に優れる。但し、68%未満では比重増加（密度増加）、歪点低下、膨張係数増加、耐酸性低下、耐アルカリ性低下、または耐BHF性低下が起る。SiO_2 の含有割合は好ましくは69%以上、より好ましくは70%以上である。

Al_2O_3 は、必須ではないがガラスの分相を抑制し、また歪点を高くするため、含有することが好ましい。但し、上記したように、Al_2O_3 はガラスを形成する3成分中、SiO_2 に比べて$\Delta_{an-st}/\alpha_{50-350}$を大きくする。そのため、本発明のガラスは$Al_2O_3$ の含有割合が低いことが好ましい。具体的には、本発明のガラスは、Al_2O_3 の含有割合が0%以上12%未満である。Al_2O_3 の含有割合は、好ましくは11．5%以

下であり、より好ましくは１１．０％以下であり、さらに好ましくは１０．５％以下であり、さらに好ましくは１０．０％以下であり、９．５％以下であることが特に好ましい。下限値は特に限定されないが、分相抑制のためには適量添加することが好ましく、５％以上であることが好ましい。Al_2O_3 が５％以上であると、ガラスの分相を抑制する効果、および歪点を高める効果に優れている。Al_2O_3 の含有割合は、好ましくは６％以上、より好ましくは７％以上、さらに好ましくは７．５％以上、特に好ましくは８％以上である。Al_2O_3 が８％以上であると、ガラスの分相を抑制する効果、および歪点を高める効果が特に優れている。

SiO_2 とAl_2O_3 の含有量の合計は７６％以上であることが好ましく、より好ましくは７７％以上、特に好ましくは７９％以上である。この合計が７６％以上であると歪点を高める効果に優れている。

B_2O_3 は比重（密度）を小さくし、耐ＢＨＦ性を高くし、ガラスの溶解性を高くし、失透しにくくし、また膨張係数を小さくする成分であり、必須である。但し、上記したように、ガラスを形成する３成分中、Δ_{an-st} ／α_{50-350}を最も大きくする。そのため、本発明のガラスはB_2O_3 の含有割合が低いことが好ましい。B_2O_3 は化学物質管理促進法の指定化学物質であるので、B_2O_3 の含有割合が低いことは環境への影響を考えても好ましいことである。具体的には、本発明のガラスはB_2O_3 の含有割合が０％超７％未満である。下限値は特に限定されないが、２％以上であることが好ましい。B_2O_3 の含有割合が２％以上であると、比重（密度）がより小さく、耐ＢＨＦ性およびガラスの溶解性に優れており、膨張係数を小さくする効果が優れており、かつより失透しにくくなる。B_2O_3 の含有割合は、好ましくは３％以上、より好ましくは４％以上、さらに好ましくは４．５％以上であり、最も好ましくは５％以上である。B_2O_3 の含有割合が、４．５％以上であると、成形性、失透温度の低減および耐ＢＨＦ性に特に優れる。また、基板の軽量化にも寄与する。

SiO_2 とB_2O_3 の含有量の合計$SiO_2+B_2O_3$ は７５％以上であることが好ましく、より好ましくは７７％以上、さらに好ましくは７８％以上、最も好ましくは７９％以上である。この含有量の合計が７５％以上であると、比重（密度）および膨張係数が適度な値である。

Al_2O_3の含有量をB_2O_3の含有量によって除したAl_2O_3/B_2O_3は、2.0以下であることが好ましく、より好ましくは1.7以下、さらに好ましくは1.6以下、特に好ましくは1.5以下である。Al_2O_3/B_2O_3が2.0以下であると、耐BHF性に優れている。また、Al_2O_3/B_2O_3は0.8以上であることが好ましく、0.8以上であると、歪点を高める効果に優れている。Al_2O_3/B_2O_3はより好ましくは0.9以上、特に好ましくは1.0以上である。

Al_2O_3とB_2O_3の含有量の合計をSiO_2の含有量によって除した$(Al_2O_3+B_2O_3)/SiO_2$は、0.32以下であることが好ましく、より好ましくは0.31以下、特に好ましくは0.30以下、最も好ましくは0.29以下である。この値が0.32超では耐酸性が低下するおそれがある。

MgOは必須ではないが、比重（密度）を小さくし、ガラスの溶解性を高くするため、含有することが好ましい。MgOが12%超ではガラスが分相しやすくなる、失透しやすくなる、耐BHF性が低下する、または耐酸性が低下する。なお、ガラスの分相抑制、失透防止、耐BHF性および耐酸性の向上という観点から、MgOの含有割合は10%以下であることが好ましい。また、MgOの含有割合が10%以下であると、ガラスの溶解性に優れている。下限値は特に限定されないが、上記したように、ガラスを溶融させる融剤成分（MgO, CaO, SrO, BaO）中、$\Delta_{an-st}/\alpha_{50-350}$を最も小さくすることから、本発明のガラスは、MgOの含有割合を大きくすることが好ましい。具体的には、本発明のガラスは、MgOの含有割合が2%以上であることが好ましく、より好ましくは、3%以上であり、さらに好ましくは4%以上であり、さらに好ましくは5%以上であり、6%以上であることが特に好ましい。

CaOは必須ではないが、比重（密度）を小さくするため、ガラスの溶解性を高くするため、または失透しにくくするために15%まで含有してもよい。CaOの含有割合が15%超では、比重増加（密度増加）または膨張係数増加が起るおそれがあり、また、かえって失透しやすくなるおそれがある。CaOは、好ましくは12%以下、より好ましくは10%以下、さらに好ましくは8%以下、特に好ましくは7%以下であり、最も好ましくは6%以下である。CaOを含有する場合、その含有量は0.5%以上であることが好ましい。より好ましくは1%以上、さらに好ましくは2%以上であり、特に好ましくは2.

５％以上である。ＣａＯの含有割合が２．５％以上７％以下であると、ガラスの溶解性を高めつつ、失透特性を向上させるうえで特に優れている。

ＭｇＯの含有量をＭｇＯとＣａＯの含有量の合計によって除したＭｇＯ／（ＭｇＯ＋ＣａＯ）は、０．２以上であることが好ましく、より好ましくは０．２５以上、特に好ましくは０．４以上である。ＭｇＯ／（ＭｇＯ＋ＣａＯ）が０．２以上であると、比重（密度）および膨張係数が適度な値であり、Δ_{an-st}／α_{50-350}を最小化するのに好ましく、かつヤング率を増大するのにも好ましい。

ＳｒＯは、必須ではないがガラスの分相を抑制し、また失透しにくくする成分であり、以下に述べる理由により含有することが好ましい。

上記したように、ガラスを溶融させる融剤成分（ＭｇＯ，ＣａＯ，ＳｒＯ，ＢａＯ）中、ＭｇＯはΔ_{an-st}／α_{50-350}を小さくすることから、本発明のガラスは、ＭｇＯの含有割合を大きくすることが好ましい。しかしながら、ＭｇＯを多く含有させると、ガラスが比較的失透しやすくなる。本発明者らは、ガラスにＳｒＯを適度な量含有させると、ガラスを失透させることなしに、ＭｇＯの含有量を高くすることができることを見いだした。但し、ＳｒＯは、４％超ではガラスの比重（密度）が大きくなりすぎる。ＳｒＯは好ましくは３％以下、より好ましくは２．５％以下である。但し、ガラスを失透させることなしに、ＭｇＯの含有量を高めるためには、０．１％以上含有することが好ましく、より好ましくは０．５％以上であり、さらに好ましくは１％以上であり、さらに好ましくは１．５％以上であり、２％以上であることが特に好ましい。

ＢａＯは必須ではないが、ガラスの分相を抑制し、また失透しにくくするために１％まで含有してもよく、好ましくは０．５％以下である。ＢａＯが１％超では比重（密度）が大きくなりすぎる。比重（密度）をより小さくしたい場合はＢａＯを含有しないことが好ましい。ＢａＯは、化学物質管理促進法で劇物に指定されているため、ＢａＯを含有しないことは環境への影響を考えても好ましいことである。

ＳｒＯとＢａＯの含有量の合計ＳｒＯ＋ＢａＯは６％以下であることが好ましく、より好ましくは４％以下である。この合計量が６％超では比重（密度）が大きくなりすぎるおそれがある。比重をより小さくしたい場合、または$SiO_2 + B_2O_3$が７９％以下の場合、ＳｒＯ＋ＢａＯは好ましくは４％以下、より好ましくは３％以下である。なお、より

失透しにくくしたい場合には、ＳｒＯ＋ＢａＯは０．５％以上であることが好ましく、より好ましくは１％以上であり、さらに好ましくは２％以上である。

本発明のガラスは、ＭｇＯ、ＣａＯ、ＳｒＯおよびＢａＯの含有割合の合計、すなわちＭｇＯ＋ＣａＯ＋ＳｒＯ＋ＢａＯ（ＲＯ）が、５％以上１８％以下である。ＲＯが１８％超であると、比重（密度）が大きくなりすぎるおそれがあり、また、膨張係数が大きくなりすぎるおそれがある。ＲＯは、１６．５％以下であることが好ましい。ＲＯが１６．５％以下であれば、比重および膨張係数が適度な値となる。

また、ＭｇＯ＋ＣａＯ＋ＳｒＯ＋ＢａＯ（ＲＯ）は５％未満では、ガラスの溶解性が低下するおそれがある。ＲＯはより好ましくは５．５％以上、さらに好ましくは６％以上、特に好ましくは７％以上である。

本発明のガラスは実質的に上記成分からなるが、その他の成分を本発明の目的を損なわない範囲で含有してもよい。前記その他の成分の含有量の合計は１０モル％以下であることが好ましく、より好ましくは５％以下である。

前記その他成分として次のようなものが挙げられる。すなわち、SO_3、Ｆ、Ｃｌ、SnO_2等を、溶解性、清澄性、成形性を向上させるために、下記範囲で適宜含有してもよい。

SO_3	０～２モル％、好ましくは０～１モル％
Ｆ	０～６モル％、好ましくは０～３モル％
Ｃｌ	０～６モル％、好ましくは０～４モル％
SnO_2	０～４モル％、好ましくは０～１モル％

なお、これらを含有させる場合、含有量の合計が１０モル％まで、好ましくは５モル％まで、より好ましくは３モル％まで、特に好ましくは２モル％まで、更に好ましくは１ｐｐｍ～２モル％の範囲である。

また、同様の理由によりFe_2O_3、ZrO_2、TiO_2、Y_2O_3等を下記範囲で適宜含有してもよい。

Fe_2O_3	０～１モル％、好ましくは０～０．１モル％
ZrO_2	０～２モル％、好ましくは０～１モル％
TiO_2	０～４モル％、好ましくは０～２モル％

Y_2O_3　　0～4モル%、好ましくは0～2モル%

CeO_2　　0～2モル%、好ましくは0～1モル%

なお、上記その他の成分を含有させる場合、含有量の合計（SO_3 +F+Cl+SnO_2 +Fe_2O_3 +ZrO_2 +TiO_2 +Y_2O_3 +CeO_2）が15モル%まで、好ましくは10モル%まで、より好ましくは5モル%まで、特に好ましくは3モル%まで、更に好ましくは1ppm～3モル%の範囲である。

なお、環境およびリサイクルを考慮すると、As_2O_3、Sb_2O_3、PbO、ZnOおよびP_2O_5は実質的に含有しないことが好ましい。すなわち、これら5成分の含有量はそれぞれ0．1%以下であることが好ましい。これら5成分の含有量は、合計で0．1%以下であることがより好ましい。

但し、ZnOについては、特にフロート法による成形を行う場合は実質的に含有しないことが好ましいが、その他の成形法、たとえばダウンドロー法による成形を行う場合には0．1%を超えて適宜含有してもよい。特に、失透しにくくしたい場合には、2%までの範囲で含有することが好ましい。ZnOの含有量が2%超では比重（密度）が大きくなりすぎるおそれがある。

また、As_2O_3、Sb_2O_3、特にSb_2O_3については、より清澄性を向上させたい場合には0．1%を超えて適宜含有してもよい。

TiO_2はフロート法による成形を行う場合は実質的に含有しないことが好ましいが、その他の成形法、たとえばダウンドロー法による成形を行う場合には0．1%を超えて適宜含有してもよい。特に、失透しにくくしたい場合には、2%までの範囲でTiO_2を含有することが好ましい。TiO_2の含有量が2%超では比重（密度）が大きくなりすぎるおそれがある。

本発明のガラスの比重（密度）は2．46g／cm^3以下であることが好ましい。ガラスの比重が2．46g／cm^3以下であるとディスプレイの軽量化にとって好都合である。ガラスの比重は、より好ましくは2．43g／cm^3以下、さらに好ましくは2．40g／cm^3以下、特に好ましくは2．39g／cm^3以下、最も好ましくは2．38g／cm^3以下である。

本発明のガラスの50～350℃における平均線膨張係数α_{50-350}は、3．4×10^{-}

^{6}／℃以下であることが好ましく、より好ましくは3．2×１０$^{-6}$／℃以下、特に好ましくは3．0×１０$^{-6}$／℃以下、最も好ましくは2．9×１０$^{-6}$／℃以下である。α_{50-350}が3．4×１０$^{-6}$／℃以下であると、耐熱衝撃性に優れている。また、α_{50-350}は2．4×１０$^{-6}$／℃以上であることが好ましく、2．4×１０$^{-6}$／℃以上であると、ガラス基板上にSiO_xやSiN_xを成膜した場合に、ガラス基板とこれらの膜との膨張マッチングが良好である。この観点からは、α_{50-350}はより好ましくは2．6×１０$^{-6}$／℃以上、さらに好ましくは2．7×１０$^{-6}$／℃以上である。

コンパクションを低減する、具体的には１９０ｐｐｍ未満とするためには、Δ_{an-st}（ｐｐｍ／℃）は0以上１２．０未満であることが好ましい。

本発明のガラスの歪点は６５０℃以上であることが好ましく、より好ましくは６６０℃以上であり、さらに好ましくは６７０℃以上であり、さらに好ましくは６８０℃以上であり、６９０℃以上であることが特に好ましい。

本発明のガラスの粘度が１０^{2} ｄＰａ・ｓとなる温度T_2は、１８４０℃以下であることが好ましく、より好ましくは１８２０℃以下であり、さらに好ましくは１８００℃以下であり、特に好ましくは１７８０℃以下、最も好ましくは１７６０℃以下である。T_2が１８４０℃以下であると、ガラスを溶解する上で好ましい。

本発明のガラスの粘度が１０^{4} ｄＰａ・ｓとなる温度T_4は、１３８０℃以下であることが好ましい。１３８０℃以下であると、ガラスを成形する上で好ましい。より好ましくは１３６０℃以下、特に好ましくは１３５０℃以下、最も好ましくは１３４０℃以下である。

本発明のガラスの液相温度における粘度η_Lは１０$^{3.5}$ ｄＰａ・ｓ以上であることが好ましい。η_Lが１０$^{3.5}$ ｄＰａ・ｓ以上であると、ガラスを成形する上で好ましい。フロート法でのガラスの成形という点、およびガラスの失透温度を低減できることからη_Lは１０$^{3.8}$ ｄＰａ・ｓ以上であることが特に好ましい。η_Lはさらに好ましくは１０^{4} ｄＰａ・ｓ以上であり、最も好ましくは１０$^{4.1}$ ｄＰａ・ｓ以上である。

特にフロート法で成形する場合には、Δ_{an-st}／α_{50-350}が3．６４未満であっても、成形性を考慮するとη_Lが１０$^{3.8}$ ｄＰａ・ｓ以上であることが好ましい。したがって、後に示す実施例１～５の中では、実施例４のガラスが成形性の面で良好である。

したがって、本発明のガラスの好適な実施形態は、下記組成を有し、Δ_{an-st}／α_{50-350}が、0以上3．5以下であって、液相温度における粘度η_Lが、$10^{3.8}$ dPa・s以上であることを特徴とする無アルカリガラスである。

68%≦SiO_2≦72．5%

8%≦Al_2O_3≦10．5%

4．5%≦B_2O_3＜7%

3%≦MgO≦10%

2．5%≦CaO≦7%

0%≦SrO≦4%

0%≦BaO≦1%

5．5%≦RO≦18%

本発明のガラスを、濃度が0．1モル／リットルである塩酸水溶液中に90℃で20時間浸漬したとき、その表面に白濁、変色、クラック等が生じないことが好ましい。また、ガラスの表面積と前記浸漬によるガラスの質量変化とから求めたガラスの単位表面積当りの質量減少量（ΔW_{HCl}）が0．6mg／cm^2 以下であることが好ましい。（ΔW_{HCl}）はより好ましくは0．4mg／cm^2 以下、特に好ましくは0．2mg／cm^2 以下、最も好ましくは0．15mg／cm^2 以下である。

また、本発明のガラスを、質量百分率表示濃度が40%であるフッ化アンモニウム水溶液と同表示濃度が50%であるフッ酸水溶液とを体積比で9：1に混合した液（以下、バッファードフッ酸（BHF）液という。）中に25℃で20分間浸漬したとき、その表面が白濁しないことが好ましい。以下、このバッファードフッ酸液を用いた評価を耐BHF性評価といい、前記表面が白濁しない場合を耐BHF性が良好であるという。また、ガラスの表面積と前記浸漬によるガラスの質量変化とから求めたガラスの単位面積当りの質量減少量（ΔW_{BHF}）が0．6mg／cm^2 以下であることが好ましい。（ΔW_{BHF}）はより好ましくは、0．5mg／cm^2 以下であり、さらに好ましくは0．4mg／cm^2 以下である。

本発明のガラスを製造する方法は特に限定されず、各種製造方法を採用できる。たとえば、目標組成となるように通常使用される原料を調合し、これを溶解炉中で1600℃～

１６５０℃に加熱して溶融する。バブリングや清澄剤の添加や撹拌などによってガラスの均質化を行う。液晶ディスプレイ等のディスプレイ基板やフォトマスク用基板として使用する場合は、周知のプレス法、ダウンドロー法、フロート法などの方法により所定の板厚に成形し、徐冷後、研削、研磨などの加工を行い、所定のサイズ、形状の基板とする。

従って、本発明のガラスのサイズは製造時に適宜選択され任意である。但し、本発明のガラスは、大型のガラス基板において特に有用である。すなわち、コンパクション、すなわちガラスの熱収縮の割合が同一であったとしても、基板のサイズが大きくなると、基板全体としての熱収縮の量（熱収縮の絶対値）は大きくなる。例えば、ディスプレイ用基板のサイズを２０インチ（５０．８センチメートル）対角から２５インチ（６３．５センチメートル）対角にすると、基板の対角線の長さもそれに応じて長くなり、基板全体としての熱収縮の量も大きくなる。本発明のガラスは、上記したように、加熱処理の際に発生するコンパクションが低減されているので、基板全体としての熱収縮の量も低減され、この効果は大型の基板ほど顕著となる。

本発明のガラスのサイズは、３０センチメートル角以上であることが好ましく、より好ましくは４０センチメートル角以上であり、さらに好ましくは８０センチメートル角以上であり、さらに好ましくは、１メートル角以上であり、好ましくは１．５メートル角以上であり、２メートル角以上であることが特に好ましい。ガラスの厚みについては、０．３～１．０mm程度が好適である。

（実施例）

実施例１～５、比較例

表１のSiO_2～BaOの欄にモル%表示で示した組成となるように原料を調合し、白金るつぼを用いて、１６００℃～１６５０℃で溶解した。この際白金スターラを用いて撹拌しガラスの均質化を図った。次に溶融ガラスを流し出し板状に成形し、ガラス組成から予想される徐冷点付近の温度で１時間保持した後、降温速度１℃／分で徐冷して実施例１～５、および比較例のガラスを得た。

[平均線膨張係数の測定]

得られた実施例１～５および比較例のガラスを規定の円柱に加工した後、徐冷点（T_{a} $_{n}$）付近まで加熱し、該温度で１時間保持した後、降温速度１℃／分で徐冷したサンプル

を、示差熱膨張計（TMA）を用いて、５０～３５０℃における平均線膨張係数α_{50-350}をＪＩＳ　Ｒ３１０２に規定されている方法で測定した。

[ガラスの平衡密度曲線の作成]

上記により得られた実施例１～５および比較例のガラスを約４センチ角、厚み２ミリに研磨加工した。加工したガラス試料を徐冷点（T_{an}）から歪点（T_{st}）までの複数の温度で１６時間以上温度保持した後、カーボン製板に投下し、急冷した。冷却した試料をいわゆるアルキメデス法（ＪＩＳ　Ｚ８８０７第４節）で密度を測定した。この手順で繰り返し測定を行い、０．０００１ｇ／ｃｍ^3 の桁までの再現性を確認した。複数の温度での密度測定結果から加熱処理温度に対する密度の変化の傾きを回帰して平衡密度曲線を作成し、徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域における平衡密度曲線の勾配Δ_{an-st}（ｐｐｍ／℃）を求めた。

このようにして得られたα_{50-350}およびΔ_{an-st}から、Δ_{an-st}／α_{50-350}を計算して求めた。

[コンパクションの測定]

上記により得られた実施例１～５および比較例のガラスを約５ミリ角、厚み０．７ミリに研磨加工した。加工したガラスを９００℃まで加熱し、該温度で１分間保持した後、降温速度１００℃／分で室温まで冷却して試料Ａを得た。次に、試料Ａをガラスの粘度が１７．８ｄＰａ・ｓとなる温度（理論値）まで昇温速度１００℃／時で加熱し、該温度で８時間保持した後、降温速度１００℃／時で徐冷して試料Ｂを得た。得られた試料Ａ、Ｂの密度（ｄＡ、ｄＢ）を重液法で決定した。このようにして得られた密度（ｄＡ、ｄＢ）と下記式を用いてコンパクションＣ（ｐｐｍ）を算出した。

$C=(1-(dA/dB)^{1/3})\times 10^6$

ガラスの粘度が１７．８ｄＰａ・ｓとなる温度は、徐冷点（T_{an}）（粘度：１３．０ｄＰａ・ｓ）および歪点（T_{st}）（粘度：１４．５ｄＰａ・ｓ）を用いて、横軸を１０００／Ｔ（Ｋ）、縦軸を粘度（ｄＰａ・ｓ）としてアレニウスプロットして得た。ここで、徐冷点（T_{an}）および歪点（T_{st}）は、をＪＩＳ　Ｒ３１０３に規定されている方法により測定した。

[T_2，T_4，η_L]

上記により得られた実施例１～５および比較例のガラス粘度が$10^{2.0}$ ｄＰａ・ｓとなる温度T_2（単位：℃）および粘度が10^4 ｄＰａ・ｓとなる温度T_4（単位：℃）を回転粘度計を用いて測定した。

また、回転粘度計によって得られた温度－粘度曲線と液相温度から、液相温度における粘度η_L（単位：ｄＰａ・ｓ）を求めた。液相温度については、複数のガラス片をそれぞれ異なる温度で１７時間加熱溶解し、結晶が析出しているガラスの中で最も温度が高いガラスのガラス温度と結晶が析出していないガラスの中で最も温度が低いガラスのガラス温度との平均値を液相温度とした。

［耐ＨＣｌ性（ΔW_{HCl}）］

上記により得られた実施例１～５および比較例のガラスを濃度０．１モル／リットルの塩酸水溶液中に９０℃で２０時間浸漬させて、浸漬の前後におけるガラスの質量変化を求めて、これとガラスの表面積とからガラスの単位表面積当りの質量減少量（ΔW_{HCl}（ｍｇ／ｃｍ^2））を求めた。

［耐ＢＨＦ性（ΔW_{BHF}，白濁）］

上記により得られた実施例１～５および比較例のガラスをバッファードフッ酸（ＢＨＦ）（質量百分率表示濃度が４０％であるフッ化アンモニウム水溶液と同表示濃度が５０％であるフッ酸水溶液とを体積比で９：１に混合した液）中に２５℃で２０分間浸漬させて、浸漬の前後におけるガラスの質量変化を求めて、これとガラスの表面積とからガラスの単位表面積当りの質量減少量（ΔW_{BHF}（ｍｇ／ｃｍ^2））を求めた。また、浸漬後のガラス表面における白濁の有無を目視により確認した。ここでガラス表面に白濁が認められなかった場合、耐ＢＨＦ性が良好である（評価：○）とした。

これらの結果を表１に示した。ここで比重（密度）（ｇ／ｃｍ^3）は、平衡密度曲線を作成する手順で得た徐冷点（T_{an}）から急冷させたサンプルの密度から変換した数値である。

実施例６～１４

実施例１と同様に、表１に示す組成になるように原料を調製し、溶融炉で溶解した溶融ガラスを板状に成形して、その後徐冷し実施例６～１４のガラスを得る。得られるガラスについて、α_{30-350}、比重（密度）、歪点（T_{st}）、徐冷点（T_{an}）、T_2 およびT_4

を求める。Δ_{an-st} については、各ガラス成分（SiO_2、Al_2O_3、B_2O_3、MgO、CaO、SrOの6成分）のΔに対する寄与度a_i（i＝1～6（上記6成分））を回帰計算により求め、$\Sigma a_i X_i + b$（X_iは各ガラス成分のモル分率、bは定数）から計算により求める。α_{50-350}、比重（密度）、歪点（T_{st}）、T_2 およびT_4 についても Δ_{an-st} と同様に、各ガラス成分の寄与度により計算により求める。コンパクションについては、ΔとC（コンパクション）を直線回帰し、回帰式に基づき計算により求める。得られる結果を表1に示す。

表1（1／4）

	実施例1	実施例2	比較例	実施例3	実施例4	実施例5	実施例6	実施例7	実施例8	実施例9
	mol%	mol%	mol%	mol%	mol%	mol%	mol%	mol%	mol%	mol%
SiO_2	70.5	71.1	70.0	71.6	72.1	72.7	72.1	70.0	70.5	70.8
Al_2O_3	10.1	9.5	11.0	9.0	8.5	7.8	9.5	10.5	9.8	9.7
B_2O_3	6.7	6.2	7.0	5.6	5.1	4.6	5.1	6.9	6.8	6.6
MgO	4.5	6.0	2.5	7.5	9.0	10.5	8.0	3.8	3.0	0.0
CaO	6.0	5.1	7.5	4.2	3.2	2.3	3.2	6.7	7.8	10.8
SrO	2.2	2.1	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1
BaO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RO	12.7	13.2	12.0	13.8	14.3	14.9	13.3	12.6	12.9	12.9
$SiO_2+Al_2O_3$	80.6	80.6	81.0	80.6	80.6	80.5	81.6	80.5	80.3	80.5
$SiO_2+B_2O_3$	77.2	77.3	77.0	77.2	77.2	77.3	77.2	76.9	77.3	77.4
$Al_2O_3+B_2O_3$	16.8	15.7	18.0	14.6	13.6	12.4	14.6	17.4	16.6	16.3
Al_2O_3/B_2O_3	1.51	1.53	1.57	1.61	1.67	1.70	1.86	1.52	1.44	1.47
MgO/(MgO+CaO)	0.43	0.54	0.25	0.64	0.74	0.83	0.71	0.36	0.28	0.00
SrO+BaO	2.2	2.1	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

表1（2／4）

	実施例1	実施例2	比較例	実施例3	実施例4	実施例5	実施例6	実施例7	実施例8	実施例9
Δ_{an-st} (ppm/℃)	10.1	9.7	12.0	9.1	8.6	8.2	7.3	11.3	11.3	11.3
α_{50-350} ($\times10^{-6}$/℃)	3.15	3.19	3.30	3.24	3.21	3.20	3.10	3.31	3.44	3.67
$\Delta_{an-st}/\alpha_{50-350}$	3.21	3.04	3.64	2.81	2.68	2.56	2.36	3.40	3.27	3.09
コンパクション (ppm)	178	165	190	149	137	122	98	185	185	186
比重(密度：g/cm^3)	2.424	2.424	2.424	2.436	2.435	2.435	2.431	2.439	2.443	2.458
歪点（℃）	698	699	699	683	683	682	689	683	682	687
徐冷点（℃）	750	751	751	747	748	746	756	748	744	744
T_2 （℃）	1746	1750	1742	1773	1773	1774	1781	1768	1778	1792
T_4 （℃）	1332	1334	1332	1329	1327	1325	1343	1331	1335	1350
ΔW_{HCl} (mg／cm^2)	0.03	0.03	0.06	0.05	0.05	0.05	—	—	—	—
ΔW_{BHF} (mg／cm^2)	0.45	0.46	0.46	0.50	0.52	0.55	—	—	—	—
耐BHF性（白濁）	○	○	○	○	○	○	—	—	—	—
η_L (dPa・s)	$10^{4.0}$	$10^{4.3}$	$10^{4.2}$	$10^{4.1}$	$10^{3.8}$	$10^{3.6}$	—	—	—	—
液相温度（℃）	1331	1287	1300	1315	1355	1345	—	—	—	—

表1（3／4）

	実施例10	実施例11	実施例12	実施例13	実施例14
	mol%	mol%	mol%	mol%	mol%
SiO_2	70.7	72.1	72.9	73.9	70.5
Al_2O_3	9.6	10.8	9.0	8.0	10.1
B_2O_3	6.8	6.9	6.3	6.3	6.5
MgO	1.5	2.2	7.7	5.7	4.2
CaO	9.3	4.0	2.0	4.0	5.6
SrO	2.1	4.0	2.1	2.1	3.1
BaO	0.0	0.0	0.0	0.0	0.0
RO	12.9	10.2	11.8	11.8	12.9
$SiO_2+Al_2O_3$	80.3	82.9	81.9	81.9	80.6
$SiO_2+B_2O_3$	77.5	79.0	79.2	80.2	77.0
$Al_2O_3+B_2O_3$	16.4	17.7	15.3	14.3	16.6
Al_2O_3/B_2O_3	1.41	1.57	1.43	1.27	1.55
MgO/(MgO+CaO)	0.14	0.35	0.79	0.59	0.43
SrO+BaO	2.1	4.0	2.1	2.1	3.1
Total	100.0	100.0	100.0	100.0	100.0

表1（4／4）

	実施例10	実施例11	実施例12	実施例13	実施例14
Δ_{an-st}（ppm/℃）	11.5	10.4	8.4	8.5	10.8
α_{50-350}（$\times 10^{-6}$／℃）	3.56	3.11	3.31	3.44	3.67
$\Delta_{an-st}/\alpha_{50-350}$	3.22	3.33	2.88	2.73	3.21
コンパクション（ppm）	187	180	130	131	182
比重（密度：g/cm^3）	2.449	2.431	2.439	2.443	2.458
歪点（℃）	683	689	683	682	687
徐冷点（℃）	742	756	747	741	748
T_2（℃）	1786	1806	1806	1829	1765
T_4（℃）	1341	1391	1351	1365	1341
ΔW_{HCl}（mg／cm^2）	—	—	—	—	—
ΔW_{BHF}（mg／cm^2）	—	—	—	—	—
耐BHF性（白濁）	—	—	—	—	—
η_L（dPa・s）	—	—	—	—	—
液相温度（℃）	—	—	—	—	—

産業上の利用可能性

本発明のガラスは、歪点を顕著に高くすることなしに、加熱処理の際に生じるコンパクションを低減することができる。したがって、溶融、成型といったガラス製造プロセスの温度を（顕著に）上げることなく、ディスプレイ用基板での薄膜形成工程等の加熱処理の際に発生するコンパクションを、ディスプレイ用基板に要求されるレベル以下にすることができる。

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したがって、本発明のガラスは、ディスプレイ用基板、特に、その表面にｐ－Ｓｉ　ＴＦＴが形成されるアクティブマトリクス型ＬＣＤディスプレイ用基板のような、比較的高温で加熱処理されるにもかかわらず、高い表面精度が要求されるディスプレイ用基板として好ましい。

また、コンパクションが同一であったとしても、ガラス基板のサイズが大きくなるほど、基板全体としての熱収縮の量が大きくなるので、本発明のガラスでのコンパクションの低減による効果は、大型のディスプレイ用基板において特に著しい。

本発明のガラスは、ディスプレイ用ガラス基板として好適な様々な特性を有している。すなわち、低比重（低密度）のゆえに液晶ディスプレイ等のディスプレイを軽量化でき、また低膨張係数のゆえにその製造効率を上げることができる。さらに、ＩＴＯ等のエッチングに用いられる塩酸等に対する耐久性に優れ、また、SiO_x や SiN_x のエッチングに用いられるバッファードフッ酸に対する耐久性に優れるディスプレイ基板を提供できる。加えて、失透しにくいガラスが得られ、製造効率を上げることができる。

請求の範囲

1．　徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域における平衡密度曲線の勾配Δ_{an-st}（ｐｐｍ／℃）と、５０～３５０℃における平均線膨張係数α_{50-350}（×１０$^{-6}$／℃）と、の比（Δ_{an-st}／α_{50-350}）が、０以上３．６４未満であることを特徴とする無アルカリガラス。

2．　主として以下の構成要素よりなる無アルカリガラス。

６８％≦SiO_2≦８０％

０％≦Al_2O_3＜１２％

０％＜B_2O_3＜７％

０％≦ＭｇＯ≦１２％

０％≦ＣａＯ≦１５％

０％≦ＳｒＯ≦４％

０％≦ＢａＯ≦１％

５％≦ＲＯ≦１８％

ここで、％は上記構成要素の合計を１００％とした場合のモル％であり、ＲＯはＭｇＯ＋ＣａＯ＋ＳｒＯ＋ＢａＯを表している。

3．　主として以下の構成要素よりなることを特徴とする請求の範囲１に記載の無アルカリガラス。

６８％≦SiO_2≦８０％

０％≦Al_2O_3＜１２％

０％＜B_2O_3＜７％

０％≦ＭｇＯ≦１２％

０％≦ＣａＯ≦１５％

０％≦ＳｒＯ≦４％

０％≦ＢａＯ≦１％

５％≦ＲＯ≦１８％

ここで、％は上記構成要素の合計を１００％とした場合のモル％であり、ＲＯはＭｇＯ＋

ＣａＯ＋ＳｒＯ＋ＢａＯを表している。

４．　前記徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域における平衡密度曲線の勾配Δ_{an-st}（ｐｐｍ／℃）と、５０～３５０℃における平均線膨張係数α_{50-350}（$\times 10^{-6}$／℃）と、の比（Δ_{an-st}／α_{50-350}）が、０以上３．５以下である請求の範囲１または３に記載の無アルカリガラス。

５．　前記SiO_2の含有割合が６８％≦SiO_2≦７５％である請求の範囲２ないし４のいずれかに記載の無アルカリガラス。

６．　前記Al_2O_3の含有割合が５％≦Al_2O_3≦１１．５％である請求の範囲２ないし５のいずれかに記載の無アルカリガラス。

７．前記B_2O_3の含有割合が２％≦B_2O_3＜７％である請求の範囲２ないし６のいずれかに記載の無アルカリガラス。

８．　前記ＭｇＯの含有割合が３％≦ＭｇＯ≦１０％である請求の範囲２ないし７のいずれかに記載の無アルカリガラス。

９．　前記ＣａＯの含有割合が０．５％≦ＣａＯ≦１２％である請求の範囲２ないし８のいずれかに記載の無アルカリガラス。

１０．　前記ＲＯの割合が５．５％≦ＲＯ≦１８％である請求の範囲２ないし９のいずれかに記載の無アルカリガラス。

１１．　液相温度における粘度η_Lが、$10^{3.8}$ ｄＰａ・ｓ以上である請求の範囲１ないし１０のいずれかに記載の無アルカリガラス。

１２．　主として以下の構成要素よりなり、徐冷点（T_{an}）付近から歪点（T_{st}）付近までの温度領域における平衡密度曲線の勾配Δ_{an-st}（ｐｐｍ／℃）と、５０～３５０℃における平均線膨張係数α_{50-350}（$\times 10^{-6}$／℃）と、の比（Δ_{an-st}／α_{50-350}）が、０以上３．５以下であり、液相温度における粘度η_Lが、$10^{3.8}$ ｄＰａ・ｓ以上であることを特徴とする無アルカリガラス。

６８％≦SiO_2≦７２．５％

８％≦Al_2O_3≦１０．５％

４．５％≦B_2O_3＜７％

３％≦ＭｇＯ≦１０％

2．５％≦ＣａＯ≦７％

０％≦ＳｒＯ≦４％

０％≦ＢａＯ≦１％

５．５％≦ＲＯ≦１８％

ここで、％は上記構成要素の合計を１００％とした場合のモル％であり、ＲＯはＭｇＯ＋ＣａＯ＋ＳｒＯ＋ＢａＯを表している。

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/004626

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] C03C3/091, C03C3/078, C03C3/083, C03C3/085, C03C3/087, C03C3/089

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] C03C1/00-14/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2004
Kokai Jitsuyo Shinan Koho 1971-2004 Toroku Jitsuyo Shinan Koho 1994-2004

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 11-292563 A (Nippon Electric Glass Co., Ltd.), 26 October, 1999 (26.10.99), Claims; examples (Family: none)	1-12
X	JP 2002-29775 A (Asahi Glass Co., Ltd.), 29 January, 2002 (29.01.02), Claims; examples & US 6537937 B1	1-12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 May, 2004 (24.05.04)	15 June, 2004 (15.06.04)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

国際調査報告	国際出願番号 PCT／JP2004／004626

A. 発明の属する分野の分類（国際特許分類（IPC））

Int. Cl.⁷ C03C3/091, C03C3/078, C03C3/083, C03C3/085, C03C3/087, C03C3/089

B. 調査を行った分野

調査を行った最小限資料（国際特許分類（IPC））

Int. Cl.⁷ C03C1/00-14/00

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報　１９２２－１９９６年
日本国公開実用新案公報　１９７１－２００４年
日本国実用新案登録公報　１９９６－２００４年
日本国登録実用新案公報　１９９４－２００４年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

WPI

C. 関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求の範囲の番号
X	JP 11-292563 A(日本電気硝子株式会社)1999.10.26, 特許請求の範囲, 実施例（ファミリーなし)	1-12
X	JP 2002-29775 A(旭硝子株式会社)2002.01.29, 特許請求の範囲, 実施例 & US 6537937 B1	1-12

☐ C欄の続きにも文献が列挙されている。　☐ パテントファミリーに関する別紙を参照。

＊ 引用文献のカテゴリー
「A」特に関連のある文献ではなく、一般的技術水準を示すもの
「E」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
「L」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「O」口頭による開示、使用、展示等に言及する文献
「P」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「T」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「X」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Y」特に関連のある文献であって、当該文献と他の１以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「&」同一パテントファミリー文献

国際調査を完了した日	国際調査報告の発送日
24.05.2004	15.6.2004

国際調査機関の名称及びあて先
日本国特許庁（ISA／JP）
郵便番号１００－８９１５
東京都千代田区霞が関三丁目４番３号

特許庁審査官（権限のある職員）　4T　9629
塩見　篤史

電話番号　０３－３５８１－１１０１　内線　３４６５

様式PCT／ISA／２１０（第２ページ）（２００４年１月）

AUG 04 2008
PATENT & TRADEMARK OFFICE

IAP30

IFW

PTO/SB/21 (01-08)
Approved for use through 06/30/2008. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission	14

Application Number	11/478,493
Filing Date	June 28, 2006
First Named Inventor	Adam J. G. Ellison
Art Unit	1793
Examiner Name	M. Hoban
Attorney Docket Number	ADP-231 US

ENCLOSURES *(Check all that apply)*

- [ ] Fee Transmittal Form
- [ ] Fee Attached
- [X] Amendment/Reply
- [ ] After Final
- [ ] Affidavits/declaration(s)
- [X] Extension of Time Request
- [ ] Express Abandonment Request
- [X] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
- [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
- [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [X] Other Enclosure(s) (please Identify below):
  Checks for $120.00 & $180.00
  Cited References (3 references)
  Return Receipt Postcard (1 card)

Remarks

Papers transmitted herewith:
1. Transmittal Form (PTO/SB/21; 1 page; this page)
2. Petition for Extension of Time (PTO/SB/22; 1 page; 2 copies)
3. Check for $120.00
4. Amendment (8 pages)
5. Supplemental Information Disclosure Statement (2 pages)
6. Check for $180.00
7. Listing Under 37 CFR §1.98(a)(1) (1 page)
8. Cited References (3 references)
9. Return Receipt Postcard (1 card)

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Maurice M. Klee, Ph.D.		
Signature	Maurice Klee		
Printed name	Maurice M. Klee, Ph.D.		
Date	August 1, 2008	Reg. No.	30,399

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature	Maurice Klee		
Typed or printed name	Maurice M. Klee, Ph.D.	Date	August 1, 2008

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and1.14. This collection is estimated to 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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PTO/SB/06 (07-06)
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/478,493	06/28/2006	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	08/04/2008	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 19	Minus	** 20	= 0	X $ =		OR	X $50=	0
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $ =		OR	X $210=	0
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/ROSA HOLLAND/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)	5778

22928 7590 11/28/2008

CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

EXAMINER	
HOBAN, MATTHEW E	
ART UNIT	PAPER NUMBER
1793	
MAIL DATE	DELIVERY MODE
11/28/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	11/478,493	ELLISON, ADAM J.G.	
	Examiner	Art Unit	
	Matthew E. Hoban	1793	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04 August 2008*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) *18-20* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) *1-17* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *8/4/2008*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

3. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation

under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 1-17 rejected under 35 U.S.C. 103(a) as being unpatentable over Chacon in 6831029 in view of Narita in 6,468,933.

The instant claims are directed to an alkali free glass with the following compositional characteristics:

Based on mole percent on an oxide basis the glass is comprised of:

SIO2: 64.0-71.0
A1203: 9.0-12.0
B203: 7.0-12.0
MgO: 1.0-3.0
CaO: 6.0-11.5
SrO: 0-2.0
BaO: 0-0.1

Furthermore, the ratio between divalent oxides and aluminum is between 1 and 1.25.

Several claims are also directed towards fining agents added to the composition. There are three different fining characteristics:

a) <.05 mol% antimony oxide

b) <.01 mol% tin oxide

c) <.05% arsenic oxide

One or more of these characteristics apply depending on the instant claim.

The glass also has distinct properties, where it has a density less than or equal to 2.41 grams/cc and can also have one or more of the following properties:

(a) a liquidus viscosity that is greater than or equal to 100,000 poise;
(b) a strain point that is greater than or equal to 650°C;

(c) a linear coefficient of thermal expansion (CTE) over the temperature range 0-300 °C which satisfies the relationship:

28 x 10-7/°C < CTE < 34 x 10-7/°C.

The claims are structured such that Claim 1 and 9 each include limitations regarding the composition, the ratio between RO and alumina, and the fining agents included in the

composition. For the sake of brevity and transparency, these three different sets of limitations will be addressed individually below

Regarding Claims 1, 6 and 9 (COMPOSITION): These claims include language directed towards the major oxide components of the glass.

Chacon et al teach a similar glass for use as a substrate in flat panel display devices, where her composition has overlapping ranges with the composition of the instant claims 1, 6, and 9. These ranges can be found in column 3, line 38-41 their patent.

Chacon et al. fail to teach any specific examples that are read directly on the instant claims; however, overlapping ranges have been held to establish prima facie obviousness. The ranges of Chacon further are sufficiently close to the instant claims. See MPEP 2144.05.

Accordingly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have selected from the overlapping portion of the ranges disclosed by the reference because overlapping ranges have been held to establish prima facie obviousness. See MPEP 2144.05.

Claim 6 of the instant claims serves to further adjust the SrO level in the glass to below 1 mol%; however, Dumbaugh's range of SrO is inclusive of 0 mol% and he teaches that

SrO content as well as BaO content should be minimized because these oxides negatively affect the glass density.

Regarding Claims 1, 9, 10 (RO/AL2O3 ratio): These claims include language regarding the ratio of the sum of divalent metal oxides to aluminum oxide. These claims specify that the ratio between these two must be between 1 and 1.25.

It is clearly stated at Column 5, lines 18-25 that the ratio between RO and alumina in the glass composition is between .9 and 1.2 in this composition. This range reads on the instantly claimed range/

Regarding Claims 1-5, 9, 13-17 (FINING AGENTS): These claims include language regarding the fining agent added to the glass composition (or have dependant claims associated to them regarding this aspect)

The composition of Dumbaugh teaches the use of conventional fining agents such as arsenic oxide, antimony, and tin (See Column 5, lines 35-45). These fining agents can be added in an amount of up to 1 mol%. The problem arises with Dumbaugh's examples, which only show fining where antimony and arsenic are included with tin as

cofining agents. So, although Dumbaugh does teach that tin is a possible fining agent, he doesn't teach its inclusion in a sufficient amount in his examples to make the claims obvious.

However, Narita does disclose the use of tin oxide as a replacement fining agent for arsenic oxide. In the background of his invention (Section (2) Prior Art in Column 1) Narita explains that alkali free glasses, such as the one that is the subject of his teachings, as well as those of Dumbaugh, are typically used as a glass substrate for a liquid crystal display. An important aspect of these glasses is the creation of a glass without bubbles. This is done by adding fining agents, which generate a fining gas in the melt. This melting process is usually at a high temperature, due to the lack of alkali-oxides, so the selection of a fining agent is dependant on this fact. Previously, arsenic oxide was used as a fining agent, but as is commonly known and also taught by Narita, arsenic oxide is very toxic and causes pollution. To solve this issue, Narita uses a Tin Oxide and Chloride instead of arsenic oxide (See Column 1, Lines 54-58). As can be seen in his examples as well as in Tables 2-5, tin oxide and chloride are added in an amount of .05-2 wt% and .005-1 wt% respectively. These figures in the context of Narita's specific examples generally translate to .025-1 mol% and .005-1 mol%, respectively. For example, composition 9 in Table 5 contains .9 wt% or .42 mol% tin oxide. As stated, Narita's compositions are substantially arsenic free, meaning they have less than .02 mol% Arsenic is present (See Column 3, Lines 56-60). Narita is silent as to the amount of antimony in the composition, but because tin oxide and

chloride are the only fining agents, one of ordinary skill in the art would find it obvious that the amount of antimony would also be less than .05 mol%.

The fining agent of Narita, Tin Oxide and Chloride, could be directly incorporated into the composition of Dumbaugh. Dumbaugh states that a possible fining agent in his composition is arsenic oxide, where Narita teaches his fining agents as a replacement for arsenic oxide. When combining these two references, only tin oxide and chloride would be used for fining in the same wt% as the teachings of Narita, whose teachings teach an amount of tin oxide greater than .01 mole percent, with no antimony oxide or arsenic oxide. This combination of fining agents makes obvious all fining characteristics found in claims 1-5 and 13-17.

The combination of these teachings would produce less toxic gas during manufacturing, which would have been obvious motivation for one of ordinary skill in the art at the time the invention was made. Furthermore, these two fining agents (arsenic and tin oxide) according to Narita perform entirely the same function, meaning that they are generally interchangeable and create no unexpected results.

Regarding Claims 7 and 11: These claims are directed towards the density of the glass, which must be less than 2.41 g/cc

The glass of Chacon is stated as having a density less than about 2.4 g/cc (See Column 4, Lines 15-25). The glasses of Chacon in view of Narita would also have a similar density, since the change in fining agents would not dramatically impact the final density of the glass.

Regarding Claims 8 and 12: These claims are directed towards properties of the glass, where only one property must be present selected among a liquidus viscosity greater than 100,000 poise, a strain point greater than 650 C, and a linear coefficient of thermal expansion of between 28-34e-7

Chacon teaches a glass having all of these properties as can be seen in Column 4, Lines 15-45. The glass must have a strain point greater than 660C, a CTE of between 28 and 33E-7 and a liquidus viscosity of greater than about 200,000 poises.

Response to Arguments

1. Applicant's arguments with respect to claim 1 have been considered but are moot in view of the new ground(s) of rejection. The arguments were directly towards Dumbaugh, which is no longer relied upon to reject the claims. No mention was made of Narita, which still is relied upon in this rejection. Applicant speaks at length about the '884 reference of Nishizawa, which was filed in an IDS. Although not relied upon in this rejection, the glass composition of Nishizawa seems applicable, albeit being a

comparitive example. It should be noted that Nishizawa suggestively states the use of Tin Oxide as a fining agent.

Conclusion

2. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew E. Hoban whose telephone number is (571) 270-3585. The examiner can normally be reached on Monday - Friday from 7:30 AM to 5 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jerry Lorengo can be reached on (571) 272-1233. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/J.A. LORENGO/
Supervisory Patent Examiner, Art Unit 1793

meh

Notice of References Cited	Application/Control No. 11/478,493	Applicant(s)/Patent Under Reexamination ELLISON, ADAM J.G.	
	Examiner Matthew E. Hoban	Art Unit 1793	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2002/0023463	02-2002	Siebers et al.	65/99.5
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11478493	ELLISON, ADAM J.G.
	Examiner	**Art Unit**
	Matthew E Hoban	1793

SEARCHED

Class	Subclass	Date	Examiner
501	+text	3/20/2008	meh

SEARCH NOTES

Search Notes	Date	Examiner
See East Search History	3/20/2008	meh
Inventor Search Completed through PALM	3/20/2008	meh
See EAST search history	11/24/2008	mh

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	"20060003884"	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/24 09:30
L2	40	"4180618" "6881692"	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/24 09:36
S35	18	"733189"	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 10:10
S36	4	"7133189"	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 10:10
S37	28	("2231811" | "2961328" | "3338696" | "3682609" | "4394453" | "4824808" | "5116788" | "5244847" | "5374595" | "5506180" | "5508237" | "5770535" | "5801109" | "5811361" | "5851939" | "5885914" | "6060168" | "6096670" | "6169047" | "6250111" | "6319867" | "6468933").PN. OR ("6831029").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:23
S38	28	("2231811" | "2961328" | "3338696" | "3682609" | "4394453" | "4824808" | "5116788" | "5244847" | "5374595" | "5506180" | "5508237" | "5770535" | "5801109" | "5811361" | "5851939" | "5885914" | "6060168" | "6096670" | "6169047" | "6250111" | "6319867" | "6468933").PN. OR ("6831029").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47

S39	0	S38 not S37	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47
S40	27	("2231811" | "2961328" | "3338696" | "3682609" | "4394453" | "4824808" | "5116788" | "5244847" | "5374595" | "5506180" | "5508237" | "5770535" | "5801109" | "5811361" | "5851939" | "5885914" | "6060168" | "6096670" | "6169047" | "6250111" | "6319867" | "6468933" | "6831029").PN. OR ("7365038").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47
S41	1	S40 not S38	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47
S42	762160	toxic (tin "SnO.sub.2")	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:51
S43	45	toxic same (tin "SnO. sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:51
S44	122	free same ("Sb.sub.2O. sub.3" or "Sb.sub.2 O. sub.3" antimony) same (Arsenic "As.sub.2O. sub.3" "As.sub.2 O. sub.3") and (tin "SnO. sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:06
S45	6	free same toxic same ("Sb.sub.2O.sub.3" or "Sb.sub.2 O.sub.3" antimony) same (Arsenic "As.sub.2O. sub.3" "As.sub.2 O. sub.3") and (tin "SnO. sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:07

S46	27	toxic same ("Sb. sub.2O.sub.3" or "Sb. sub.2 O.sub.3" antimony) same (Arsenic "As.sub.2O. sub.3" "As.sub.2 O. sub.3") and (tin "SnO. sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:09
S47	2	"20020042337"	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:42
S48	9	(US-20040209758-$). did. or (US-6468933-$ or US-5801109-$ or US-5885914-$ or US-7365038-$ or US-6831029-$ or US-6169047-$ or US-6306786-$ or US-6846760-$).did.	US-PGPUB; USPAT	OR	ON	2008/11/21 10:05
S49	3	S48 and toxic	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/21 10:05

11/24/2008 9:40:59 AM
C:\Documents and Settings\mhoban\My Documents\EAST\Workspaces\11478493.wsp

Receipt date: 08/04/2008

OIPE IAP30 AUG 04 2008 PATENT & TRADEMARK OFFICE

11478493 - GAU: 1793

[298] Attorney Docket No. : ADP-231 US PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Serial No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT BY APPLICLANT
(Listing Under 37 CFR §1.98(a)(1))

11/24/2008

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name
/M.H./	1.	4,180,618	12/1979	Alpha et al.
/M.H./	2.	6,881,692	04/2005	Murata et al.
/M.H./	3.	2006/0003884	01/2006	Nishizawa et al.

FOREIGN PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Country
/M.H./	4.	2001-348247	12/2001	JP
		with attached English abstract and computer translation obtained from the Japanese Patent Office website		
/M.H./	5.	2004-189535	07/2004	JP
		with attached English abstract and with attached English translation		
/M.H./	6.	2004/087597*	10/2004	WO
		with English abstract		

08/05/2008 ETECLE1 00000046 11478493
02 FC:1806 180.00 OP

/Matthew Hoban/ 11/24/2008

*Corresponds to US 2006/0003884 (Reference 3 above).

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[305] Atty Dkt: ADP-231 US (SP05-073)

MAIL STOP AF- PATENT
Response Under
37 CFR §1.116
Expedited Procedure
Examining Group 1793

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO FINAL REJECTION

This is in response to the final Office Action dated November 28, 2008. In that Office Action, the Examiner rejected applicant's Claims 1-17 as allegedly unpatentable under 35 U.S.C. 103(a) over Chacon et al., U.S. Patent No. 6,831,029 (Chacon), in view of Narita et al., U.S. Patent No. 6,468,933 (Narita).

In particular, the Examiner noted that various of the claims of the present application have ranges that overlap with those disclosed in the Chacon patent and cited Section 2144.05 of the MPEP for the proposition that overlapping ranges can establish a *prima facie* case of obviousness. The Examiner cited Narita for its disclosure of the use of a combination of tin oxide and chloride in place of arsenic oxide as a fining agent for liquid crystal display glasses. The Examiner acknowledged that "Chacon et al. fail to teach any specific examples that are read directly on the instant claims..." (11/28/08

Office Action at page 5.) Although not explicitly stated in the Office Action, the same is true of Narita, i.e., applicant's claims do not read on Narita.[1]

Under the heading "Rebuttal of *Prima Facie* Case of Obviousness," Section 2144.05 of the MPEP states in relevant part:

> Applicants can rebut a *prima facie* case of obviousness based on overlapping ranges by showing the criticality of the claimed range. "The law is replete with cases in which the difference between the claimed invention and the prior art is some range or other variable within the claims. . . . In such a situation, the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range." *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990)....

Applicant respectfully submits that this is such a case. Submitted herewith is the Declaration of Adam J. Ellison Under 37 C.F.R. §1.132 (the Ellison Declaration), which discusses the criticality of applicant's MgO and RO/Al_2O_3 limitations with regard to tin fining and, in particular, the unexpected and abrupt increase in the number of blisters that arises when the RO/Al_2O_3 ratio drops below 1.00, even by a small amount.

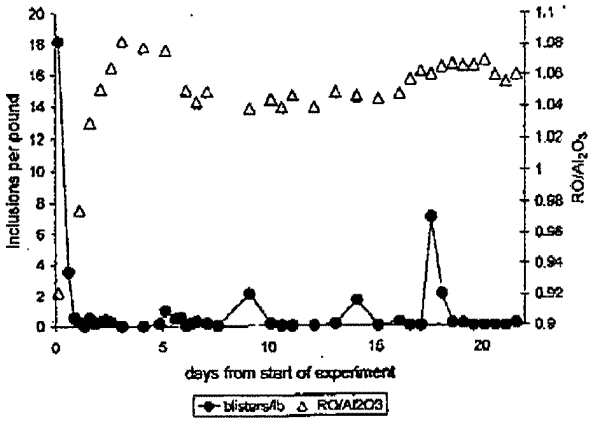
As explained in his declaration, Dr. Ellison is one of the inventors of the Chacon patent and the work of the present application was performed to improve the glasses of that patent. In particular, Dr. Ellison was seeking glasses that could be fined using tin oxide and still had the strain point, CTE, and density properties desired by manufacturers of liquid crystal displays and a liquidus viscosity greater than or equal to 100,000 poises so that the glass could be manufactured by, for example, the fusion process.

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[1] On pages 3-4 of the Office Action, the Examiner summarized various of the limitations of applicant's claims. The claims, of course, speak for themselves. However, applicant would like to note that there are a number of errors in the summary. For example, independent Claim 9's ranges are not the same as those of independent Claim 1 and the summaries use "<" symbols where applicant's claims use "≤" symbols or the equivalent in words. Also, applicant's Claim 1 specifies that the concentration of tin oxide is greater than or equal to 0.01 mole percent, not less than 0.01 mole percent. In addition, at various places, the Office Action refers to the Dumbaugh patent, which applicant has assumed should be references to the Chacon patent.

In the course of his work, Dr. Ellison found that in order to use tin fining it was critical that the glass have both a MgO content greater than or equal to 1.0 mole percent and a RO/Al_2O_3 ratio greater than or equal to 1.00. The importance of this combination of compositional properties was not recognized when the work underlying the Chacon patent was performed and none of the 32 examples of that patent have both these properties. In particular, only two of the 32 examples of the Chacon patent use more than 1.0 mol% MgO (Examples 8 and 21) and those examples have a RO/Al_2O_3 ratio below 1.00 and do not use tin fining.

The importance of having the glass' MgO content greater than or equal to 1.0 mole percent is discussed at, for example, paragraphs [0085] - [0088] of applicant's published application. The effect of the RO/Al_2O_3 ratio on inclusions (blisters) during tin fining is illustrated in applicant's Figure 3, a copy of which is reproduced below.

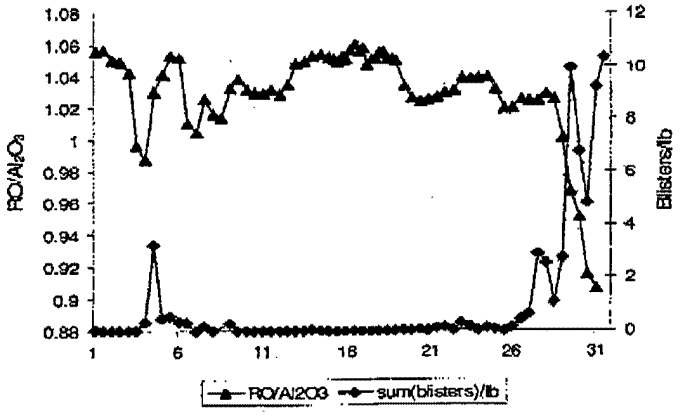


As can be seen in this figure, as the RO/Al_2O_3 ratio rises through 1.00 (see the triangular data points), the number of blisters/pound drops precipitously (see the circular data points). However, an examination of Figure 3 reveals that it only has a few data points close to the 1.00 value for the RO/Al_2O_3 ratio. The Ellison Declaration provides additional data that demonstrates the sensitivity of tin fining to the 1.00 value of the RO/Al_2O_3 ratio.

In particular, the experiments reported in the Ellison Declaration show that a RO/Al_2O_3 ratio of 1.00 is the cutoff for successful tin fining. Specifically, those experiments show that a RO/Al_2O_3 ratio of 1.00 or above leads to successful tin fining (assuming $MgO \geq 1.0$), while a RO/Al_2O_3 ratio below 1.00 does not work, in that the number of blisters per pound in the glass rises to commercially unacceptable levels.

The experiments reported in Dr. Ellison's Declaration were performed using the techniques and equipment, i.e., the laboratory scale melter, described in paragraph [0107] of applicant's published application. The glass' base composition was that of Example 24. The fining agent was tin oxide and neither arsenic nor antimony were used. The experiments preceded those of Figure 3 and had originally been designed to test the effects of varying the relative amounts of the alkaline earth oxides in the glass, while holding the sum of those oxides constant. However, through a batching error, the same amount of SrO was used in all of the experiments, which meant that for some of the compositions, the RO/Al_2O_3 dropped below 1.00.

The following is a copy of Exhibit A to the Ellison Declaration, where the horizontal axis shows the day of the experiment, the left hand vertical axis and the triangular data points show RO/Al_2O_3 ratios, and the right hand vertical axis and the diamond data points show blister levels.



The sensitivity of the blister level to the RO/Al_2O_3 ratio is immediately evident from this graph, as is the criticality of the 1.00 value. When the RO/Al_2O_3 dropped below 1.00, even by just a hundredth, the blister level immediately jumped up, e.g., to levels of 2 blisters/pound and above. As known in the art, such blister levels are commercially unacceptable for the production of large substrates for liquid crystal displays.

As quoted above, the MPEP acknowledges that "[a]pplicants can rebut a *prima facie* case of obviousness based on overlapping ranges by showing the criticality of the claimed range." Applicant respectfully submits that the data of Figure 3 and Exhibit A satisfy this standard in that they demonstrate that commercial practice of tin fining for glasses having a MgO content greater than or equal to 1.0 mole percent, requires a RO/Al_2O_3 ratio greater than or equal to 1.00. Neither the Chacon patent nor the Narita patent contains any disclosure of this critical requirement for the successful practice of tin fining. Accordingly, applicant believes that the Examiner's rejection under Section 103 has been overcome and should be withdrawn.

In view of the foregoing, applicant believes that this application is in condition for allowance. Accordingly, reconsideration and the issuance of a Notice of Allowance are respectfully requested.[2]

Respectfully submitted,

Date: 3/30/09 Maurice Klee

Maurice M. Klee, Ph.D.
Reg. No. 30,399
Attorney for Applicant
1951 Burr Street
Fairfield, CT 06824
(203) 255-1400

[2] Submitted herewith is a petition under 37 CFR §1.136 requesting a one month extension in which to file this response. With the extension, this paper is due on March 30, 2009. No further extension of time is believed to be necessary, but if such an extension is required, applicant requests that this be considered a petition therefor. The Director is hereby authorized to charge any fees which may be required for such an extension to Deposit Account No. 11-1158.

[305] Atty Dkt: ADP-231 US (SP05-073)

MAIL STOP AF- PATENT
Response Under
37 CFR §1.116
Expedited Procedure
Examining Group 1793

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

DECLARATION OF ADAM J. ELLISON UNDER 37 C.F.R. §1.132

I, Adam J. Ellison, declare as follows:

1. I am a Senior Research Associate in the Glass Research Department at Corning Incorporated (Corning). My education and experience in the field of glass technology is as follows. I received a bachelor's degree in geology chemistry from Occidental College in 1983 and Masters and Ph.D. degrees from Brown University in geological sciences in 1985 and 1988, respectively. I did post-doctoral research at Princeton University from 1988-1991 and worked in the Materials Science and Chemical Technology Division of the Argonne National Laboratory from 1994-1996. In 1996, I joined the Glass Research Department at Corning, where I have been since that date. My work has involved glasses of various types, including glasses for liquid crystal displays (LCDs), which I have worked on since first joining Corning.

2. I am the inventor of the above-identified application. I understand that in an Office Action dated November 28, 2008, the pending claims of the application were rejected for alleged obviousness based on Chacon et al., U.S. Patent No. 6,831,029 (Chacon), in view of Narita et al., U.S. Patent No. 6,468,933 (Narita). I am one of the inventors of the Chacon patent and the work of the present application was performed to improve the glasses of that patent. In particular, I was seeking glasses that could be

fined using tin oxide and still had the strain point, CTE, and density properties desired by manufacturers of liquid crystal displays and a liquidus viscosity greater than or equal to 100,000 poises so that the glass could be manufactured by, for example, the fusion process.

3. In the course of my work, I found that in order to use tin fining it was critical that the glass have both a MgO content greater than or equal to 1.0 mole percent and a RO/Al_2O_3 ratio greater than or equal to 1.00, where Al_2O_3 is the mole percent of Al_2O_3 and RO is the sum of the mole percents of MgO, CaO, SrO, and BaO in the glass. The importance of this combination of compositional properties was not recognized when the work underlying the Chacon patent was performed and none of the 32 examples of that patent have both these properties.

4. The importance of having the MgO content greater than or equal to 1.0 mole percent is discussed at, for example, paragraphs [0085] - [0088] of my published application. FIG. 3 of my application shows the effect of the RO/Al_2O_3 ratio on inclusions (blisters) during tin fining. That figure only has a few data points close to the 1.00 value for this ratio. I make this declaration to provide additional data that demonstrates the sensitivity of tin fining to the 1.00 value of the RO/Al_2O_3 ratio.

5. In particular, I make this declaration to report on experiments conducted at Corning under my direction and supervision which demonstrate that a RO/Al_2O_3 ratio of 1.00 is the cutoff for successful tin fining. These experiments show that a RO/Al_2O_3 ratio of 1.00 or above leads to successful tin fining (assuming $MgO \geq 1.0$), while a RO/Al_2O_3 ratio below 1.00 does not work, in that the number of blisters per pound in the glass rises to commercially unacceptable levels.

6. The experiments were performed before those of FIG. 3 of my application, using the techniques and equipment, i.e., the laboratory scale melter, described in paragraph [0107] of the application. The glass' base composition was that of Example 24. The tin oxide concentration was 0.07 mole percent (0.14 wt%). Neither arsenic nor antimony were used. The experiments were conducted over a 31 day period and had originally been designed to test the effects of varying the relative amounts of

the alkaline earth oxides in the glass, while holding the sum of those oxides constant. However, through a batching error, the same amount of SrO was used in all of the experiments, which meant that for some of the compositions, the RO/Al_2O_3 dropped below 1.00.

7. Attached as Exhibit A is a graph of the data obtained from these experiments, where the horizontal axis shows the day of the experiment, the left hand vertical axis and the triangular data points show RO/Al_2O_3 ratios, and the right hand vertical axis and the diamond data points show blister levels.

8. The sensitivity of the blister level to the RO/Al_2O_3 ratio is immediately evident from this graph, as is the criticality of the 1.00 value. When the RO/Al_2O_3 dropped below 1.00, even by just a hundredth, the blister level immediately jumped up, e.g., to levels of 2 blisters/pound and above. As known in the art, such blister levels are commercially unacceptable for the production of large substrates for liquid crystal displays.

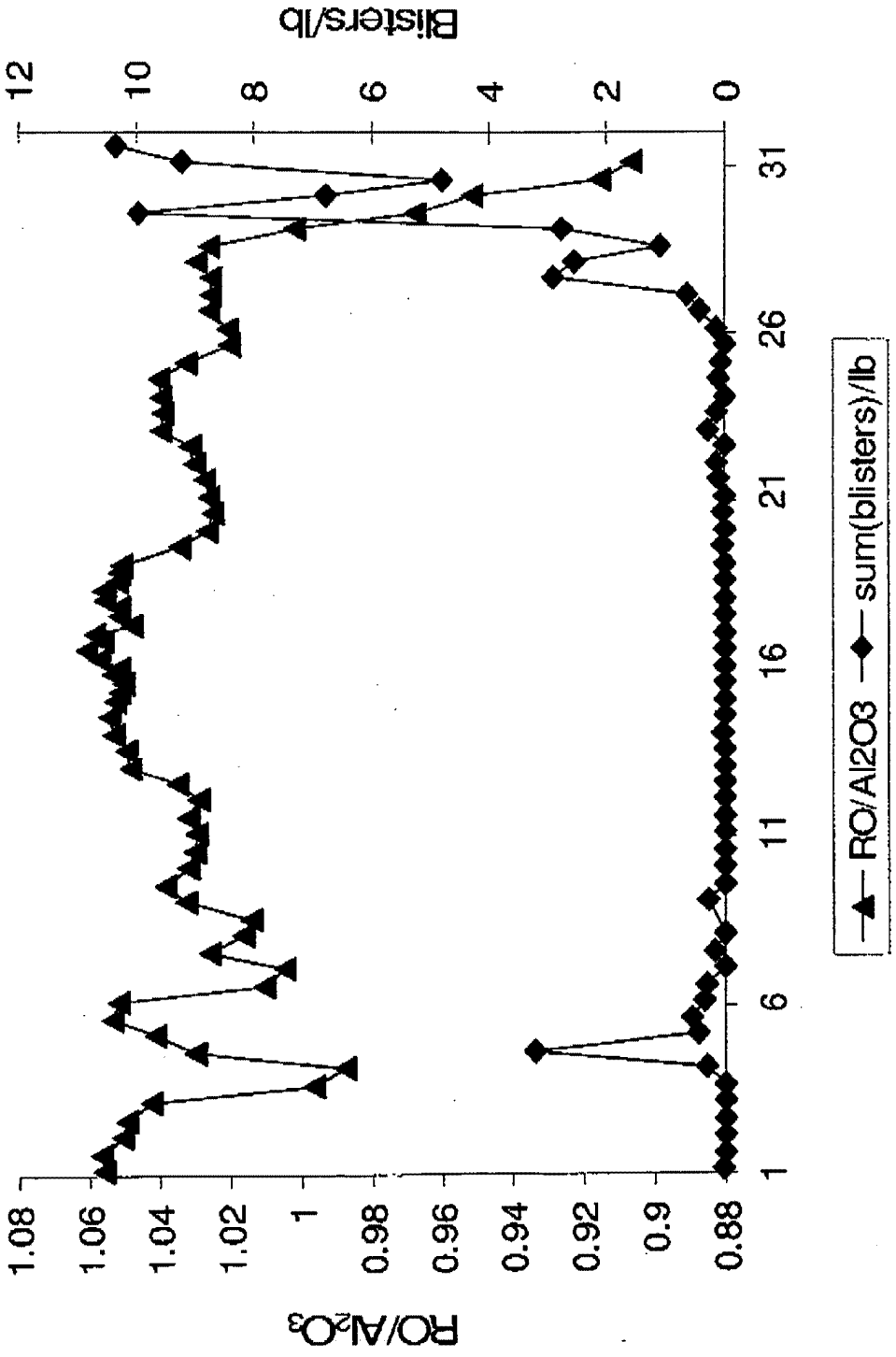
9. In summary, the data of Exhibit A demonstrates that commercial practice of tin fining for glasses having a MgO content greater than or equal to 1.0 mole percent, requires a RO/Al_2O_3 ratio greater than or equal to 1.00. Neither the Chacon patent nor the Narita patent contains any disclosure of this critical requirement for the successful practice of tin fining.

10. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

3/26/2009
(Date)

Adam J. Ellison

Exhibit A


Blisters/lb
12
10
8
6
4
2
0
RO/Al2O3
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
0.88
1
6
11
16
21
26
31
RO/Al2O3
sum(blisters)/lb

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PTO/SB/21 (12-08)
Approved for use through 01/31/2009. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission: 12

Application Number	11/478,493
Filing Date	June 28, 2006
First Named Inventor	Ellison
Art Unit	1793
Examiner Name	M. Hoban
Attorney Docket Number	ADP-231 US (SP05-073)

ENCLOSURES *(Check all that apply)*

- ☐ Fee Transmittal Form
  - ☐ Fee Attached
- ☑ Amendment/Reply
  - ☑ After Final
  - ☑ Affidavits/declaration(s)
- ☑ Extension of Time Request
- ☐ Express Abandonment Request
- ☐ Information Disclosure Statement
- ☐ Certified Copy of Priority Document(s)
- ☐ Reply to Missing Parts/ Incomplete Application
  - ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53
- ☐ Drawing(s)
- ☐ Licensing-related Papers
- ☐ Petition
- ☐ Petition to Convert to a Provisional Application
- ☐ Power of Attorney, Revocation Change of Correspondence Address
- ☐ Terminal Disclaimer
- ☐ Request for Refund
- ☐ CD, Number of CD(s) _____
  - ☐ Landscape Table on CD
- ☐ After Allowance Communication to TC
- ☐ Appeal Communication to Board of Appeals and Interferences
- ☐ Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- ☐ Proprietary Information
- ☐ Status Letter
- ☐ Other Enclosure(s) (please identify below):

Remarks

Attention: Mail Stop AF
1. Transmittal Form (PTO/SB/21; 1 page; this page)
2. Petition for Extension of Time (PTO/SB/22; 1 page)
3. Response to Final Rejection (5 pages)
4. Declaration of Adam J. Ellison Under 37 CFR §1.132 (with attached Exhibit A; 5 pages)

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Maurice M. Klee, Ph.D.		
Signature	Maurice Klee		
Printed name	Maurice M. Klee		
Date	March 30, 2009	Reg. No.	30,399

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature	Maurice Klee		
Typed or printed name	Maurice M. Klee	Date	March 30, 2009

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and1.14. This collection is estimated to 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a) FY 2009 *(Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).)*	Docket Number (Optional) ADP-231 US
Application Number 11/478,493	Filed June 28, 2006
For FINING OF BOROALUMINO SILICATE GLASSES	
Art Unit 1793	Examiner M. Hoban

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	
☑ One month (37 CFR 1.17(a)(1))	$130	$65	$ 130.00
☐ Two months (37 CFR 1.17(a)(2))	$490	$245	$
☐ Three months (37 CFR 1.17(a)(3))	$1110	$555	$
☐ Four months (37 CFR 1.17(a)(4))	$1730	$865	$
☐ Five months (37 CFR 1.17(a)(5))	$2350	$1175	$

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 111158.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed (Form PTO/SB/96).

☐ attorney or agent of record. Registration Number _____

☑ attorney or agent under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34 30399

Maurice Klee
Signature

March 30, 2009
Date

Maurice M. Klee
Typed or printed name

(203) 255-1400
Telephone Number

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below.

☐ Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

03/31/2009 VBUI11 00000002 111158 11478493
01 FC:1251 130.00 DA

PTO/SB/06 (07-06)
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/478,493	06/28/2006	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 03/30/2009

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 19	Minus	** 20	= 0	X $ =		OR	X $52=	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $ =		OR	X $220=	0
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/ADRIENE D. SELLMAN/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

DO NOT ENTER: /M.H./

DO NOT ENTER: /M.H./

[305] Atty Dkt: ADP-231 US (SP05-073)

MAIL STOP AF- PATENT
Response Under
37 CFR §1.116
Expedited Procedure
Examining Group 1793

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

DECLARATION OF ADAM J. ELLISON UNDER 37 C.F.R. §1.132

I, Adam J. Ellison, declare as follows:

1. I am a Senior Research Associate in the Glass Research Department at Corning Incorporated (Corning). My education and experience in the field of glass technology is as follows. I received a bachelor's degree in geology chemistry from Occidental College in 1983 and Masters and Ph.D. degrees from Brown University in geological sciences in 1985 and 1988, respectively. I did post-doctoral research at Princeton University from 1988-1991 and worked in the Materials Science and Chemical Technology Division of the Argonne National Laboratory from 1994-1996. In 1996, I joined the Glass Research Department at Corning, where I have been since that date. My work has involved glasses of various types, including glasses for liquid crystal displays (LCDs), which I have worked on since first joining Corning.

2. I am the inventor of the above-identified application. I understand that in an Office Action dated November 28, 2008, the pending claims of the application were rejected for alleged obviousness based on Chacon et al., U.S. Patent No. 6,831,029 (Chacon), in view of Narita et al., U.S. Patent No. 6,468,933 (Narita). I am one of the inventors of the Chacon patent and the work of the present application was performed to improve the glasses of that patent. In particular, I was seeking glasses that could be

fined using tin oxide and still had the strain point, CTE, and density properties desired by manufacturers of liquid crystal displays and a liquidus viscosity greater than or equal to 100,000 poises so that the glass could be manufactured by, for example, the fusion process.

3. In the course of my work, I found that in order to use tin fining it was critical that the glass have both a MgO content greater than or equal to 1.0 mole percent and a RO/Al_2O_3 ratio greater than or equal to 1.00, where Al_2O_3 is the mole percent of Al_2O_3 and RO is the sum of the mole percents of MgO, CaO, SrO, and BaO in the glass. The importance of this combination of compositional properties was not recognized when the work underlying the Chacon patent was performed and none of the 32 examples of that patent have both these properties.

4. The importance of having the MgO content greater than or equal to 1.0 mole percent is discussed at, for example, paragraphs [0085] - [0088] of my published application. FIG. 3 of my application shows the effect of the RO/Al_2O_3 ratio on inclusions (blisters) during tin fining. That figure only has a few data points close to the 1.00 value for this ratio. I make this declaration to provide additional data that demonstrates the sensitivity of tin fining to the 1.00 value of the RO/Al_2O_3 ratio.

5. In particular, I make this declaration to report on experiments conducted at Corning under my direction and supervision which demonstrate that a RO/Al_2O_3 ratio of 1.00 is the cutoff for successful tin fining. These experiments show that a RO/Al_2O_3 ratio of 1.00 or above leads to successful tin fining (assuming $MgO \geq 1.0$), while a RO/Al_2O_3 ratio below 1.00 does not work, in that the number of blisters per pound in the glass rises to commercially unacceptable levels.

6. The experiments were performed before those of FIG. 3 of my application, using the techniques and equipment, i.e., the laboratory scale melter, described in paragraph [0107] of the application. The glass' base composition was that of Example 24. The tin oxide concentration was 0.07 mole percent (0.14 wt%). Neither arsenic nor antimony were used. The experiments were conducted over a 31 day period and had originally been designed to test the effects of varying the relative amounts of

the alkaline earth oxides in the glass, while holding the sum of those oxides constant. However, through a batching error, the same amount of SrO was used in all of the experiments, which meant that for some of the compositions, the RO/Al_2O_3 dropped below 1.00.

7. Attached as Exhibit A is a graph of the data obtained from these experiments, where the horizontal axis shows the day of the experiment, the left hand vertical axis and the triangular data points show RO/Al_2O_3 ratios, and the right hand vertical axis and the diamond data points show blister levels.

8. The sensitivity of the blister level to the RO/Al_2O_3 ratio is immediately evident from this graph, as is the criticality of the 1.00 value. When the RO/Al_2O_3 dropped below 1.00, even by just a hundredth, the blister level immediately jumped up, e.g., to levels of 2 blisters/pound and above. As known in the art, such blister levels are commercially unacceptable for the production of large substrates for liquid crystal displays.

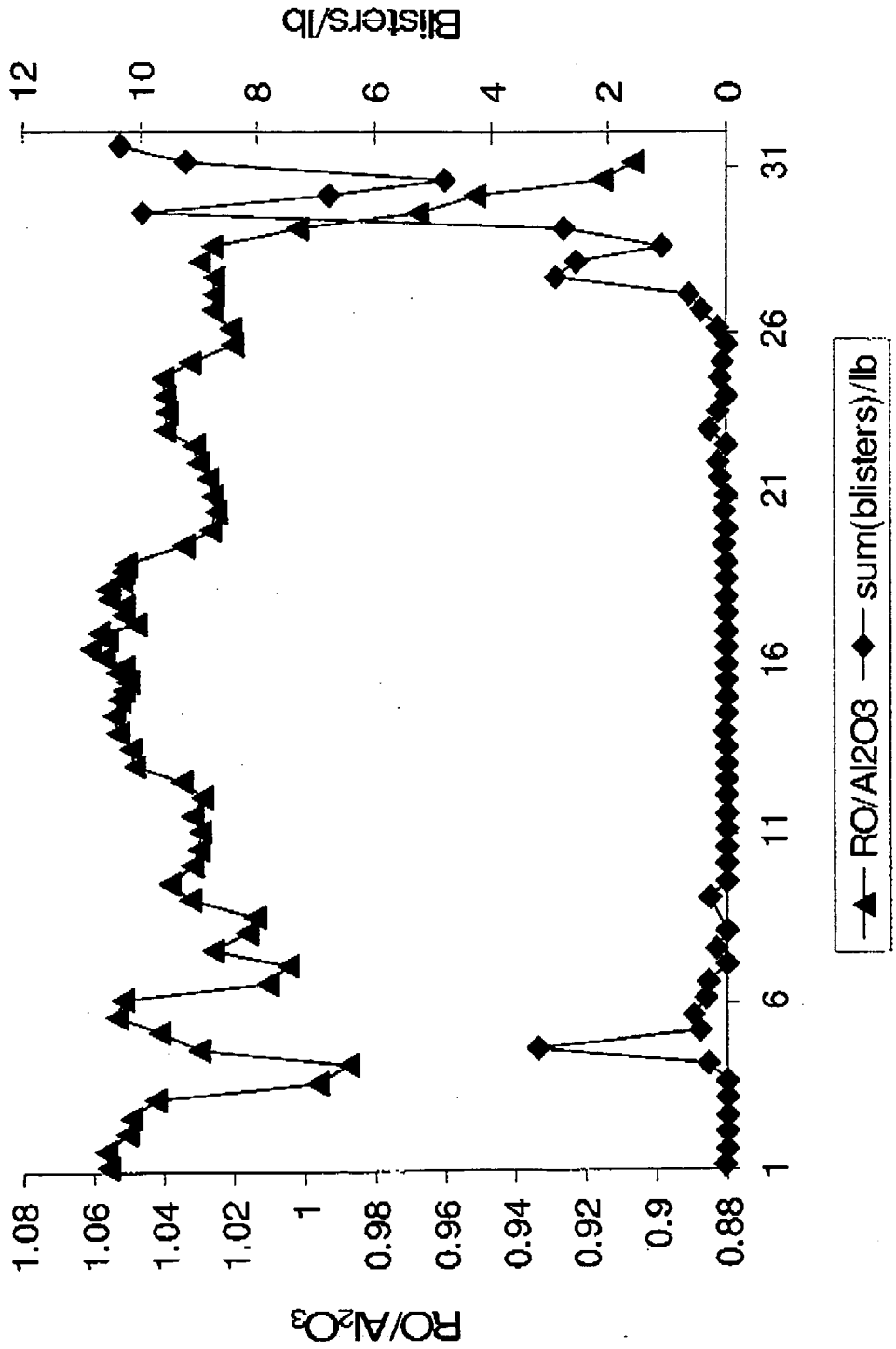
9. In summary, the data of Exhibit A demonstrates that commercial practice of tin fining for glasses having a MgO content greater than or equal to 1.0 mole percent, requires a RO/Al_2O_3 ratio greater than or equal to 1.00. Neither the Chacon patent nor the Narita patent contains any disclosure of this critical requirement for the successful practice of tin fining.

10. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

3/26/2009
(Date)

Adam J. Ellison

Exhibit A


Blisters/lb
12
10
8
6
4
2
0
RO/Al2O3
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
0.88
1
6
11
16
21
26
31
RO/Al2O3
sum(blisters)/lb

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)	5778

22928 7590 04/09/2009
CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

EXAMINER	
HOBAN, MATTHEW E	
ART UNIT	PAPER NUMBER
1793	
MAIL DATE	DELIVERY MODE
04/09/2009	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 11/478,493	**Applicant(s)** ELLISON, ADAM J.G.	
	Examiner Matthew E. Hoban	**Art Unit** 1793	

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 30 March 2009 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

1. ☐ The reply was filed after a final rejection, but prior to or on the same day as filing a Notice of Appeal. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. The reply must be filed within one of the following time periods:
   a) ☒ The period for reply expires *4* months from the mailing date of the final rejection.
   b) ☐ The period for reply expires on: (1) the mailing date of this Advisory Action, or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.

   Examiner Note: If box 1 is checked, check either box (a) or (b). ONLY CHECK BOX (b) WHEN THE FIRST REPLY WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☐ The proposed amendment(s) filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   (a) ☐ They raise new issues that would require further consideration and/or search (see NOTE below);
   (b) ☐ They raise the issue of new matter (see NOTE below);
   (c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   (d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.

   NOTE: _____. (See 37 CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicant's reply has overcome the following rejection(s): _____.
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☐ For purposes of appeal, the proposed amendment(s): a) ☐ will not be entered, or b) ☐ will be entered and an explanation of how the new or amended claims would be rejected is provided below or appended.
   The status of the claim(s) is (or will be) as follows:
   Claim(s) allowed: _____.
   Claim(s) objected to: _____.
   Claim(s) rejected: _____.
   Claim(s) withdrawn from consideration: _____.

AFFIDAVIT OR OTHER EVIDENCE

8. ☒ The affidavit or other evidence filed after a final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
9. ☐ The affidavit or other evidence filed after the date of filing a Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing a good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
10. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

11. ☒ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: See Continuation Sheet.
12. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). _____
13. ☐ Other: _____.

/J.A. LORENGO/
Supervisory Patent Examiner, Art Unit 1793

Continuation of 11. does NOT place the application in condition for allowance because: Applicant's arguments based on the declaration submitted shall not be considered at this time as this declaration has not been entered into the record as it was not timely filed. The reduction of blisters in the sample is discussed in the remarks as being an unexpected result. In the combination of references used, this may be an unexpected result when only tin is used as a refining agent; however, the teachings of Narita specifically state at column 3 that the inclusion of Chloride in the sample is to reduce the number of blisters in the final glass. Narita states that when the amount of chloride is too low it is difficult to expel the gas from the glass. The difficulty to expel such gases results in blisters as these gaseous inclusions would remain on the surface. Therefore, the combination of references fully realize that these blisters can occur when chloride is not included and thus the removal of such inclusions when chloride is added and the subsequently produced glass without blisters does not qualify as an unexpected result in as far as the claims are currently presented. Therefore, the critically of the claimed range is not established in view of the references presented based on the obvious combination of art currently applied to reject the claims.

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Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	11/478,493
Filing Date	June 28, 2006
First Named Inventor	Ellison
Art Unit	1793
Examiner Name	M. Hoban
Attorney Docket Number	ADP-231 US (SP05-073)

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

      i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

      ii. ☐ Other _____

   b. ☑ Enclosed

      i. ☑ Amendment/Reply

      ii. ☑ Affidavit(s)/ Declaration(s)

      iii. ☐ Information Disclosure Statement (IDS)

      iv. ☑ Other Letter, Petition for Extension of Time

2. Miscellaneous

   a. ☑ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of 3 months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

   b. ☐ Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

   a. ☑ The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. 111158

      i. ☑ RCE fee required under 37 CFR 1.17(e)

      ii. ☑ Extension of time fee (37 CFR 1.136 and 1.17)

      iii. ☑ Other Suspension of action fee under 37 CFR 1.103(c) and 1.17(i))

   b. ☐ Check in the amount of $ _____ enclosed

   c. ☐ Payment by credit card (Form PTO-2038 enclosed)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	Maurice Klee	Date	April 28, 2009
Name (Print/Type)	Maurice M. Klee	Registration No.	30399

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

Signature	Maurice Klee		
Name (Print/Type)	Maurice M. Klee	Date	April 28, 2009

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

04/29/2009 VBUI22 00000001 111158 11478493

01 FC:1801 810.00 DA

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PTO/SB/22 (01-09)
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a) FY 2009 *(Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).)*	Docket Number (Optional) ADP-231 US
Application Number 11/478,493	Filed June 28, 2006
For FINING OF BOROALUMINO SILICATE GLASSES	
Art Unit 1793	Examiner M. Hoban

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$130	$65	$
☑ Two months (37 CFR 1.17(a)(2))	$490	$245	$ 490-130=360
☐ Three months (37 CFR 1.17(a)(3))	$1110	$555	$
☐ Four months (37 CFR 1.17(a)(4))	$1730	$865	$
☐ Five months (37 CFR 1.17(a)(5))	$2350	$1175	$

☐ Applicant claims small entity status. See 37 CFR 1.27.

04/29/2009 VBUI22 00000001 111158 11478493
02 FC:1252 360.00 DA

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 111158.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed (Form PTO/SB/96).

☐ attorney or agent of record. Registration Number _____

☑ attorney or agent under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34 30399

Maurice Klee
Signature

April 28, 2009
Date

Maurice M. Klee
Typed or printed name

(203) 255-1400
Telephone Number

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below.

☐ Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

[306] Atty Dkt: ADP-231 US (SP05-073) PATENT

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

LETTER

Submitted herewith is a Request for Continued Examination (RCE). Pursuant to Section 706.07(h) of the MPEP, applicant is submitting herewith as the submission called for by 37 CFR 1.114 the following: (1) a copy of applicant's March 30, 2009 Response to Final Rejection; and (2) a copy of the Declaration of Adam J. Ellison Under 37 C.F.R. §1.132, which was not previously entered (see the April 9, 2009 Advisory Action).

Pursuant to 37 CFR 1.103(c), the RCE requests a 3 month suspension of action on this application. Applicant is requesting this suspension in order to provide sufficient time to address the "chlorine" question raised by the Examiner in the April 9th Advisory Action.

Also submitted herewith is a Petition for an Extension of Time Under 37 CFR 1.136(a) for a period of two months. Because a petition for a one month extension of time was filed on March 30, 2009 and the required $130.00 fee was charged to Deposit Account No. 11-1158, applicant believes that the fee for the two month extension should be $360.00, i.e., the normal $490.00 fee for two months for a large entity minus the $130.00 which has already been paid. In any event, the Director is hereby authorized to charge whatever fee is required for the extension to Deposit Account No. 11-1158.

04/29/2009 VBUI22 00000001 111158 11478493
03 FC:1464 130.00 DA

PAGE 3/14 * RCVD AT 4/28/2009 1:31:39 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-5/11 * DNIS:2738300 * CSID:2032541101 * DURATION (mm-ss):02-20

Since the final Office Action for this application was mailed on November 28, 2008, with the two-month extension, the filing of the RCE and its associated papers is due on April 28, 2009. No further extension of time is believed to be necessary for the filing of these papers, but if such an extension of time is required, applicant requests that this be considered a petition therefor. The Director is hereby authorized to charge any fees which may be required for such an extension to Deposit Account No. 11-1158.

Respectfully submitted,

Date: 4/28/09 Maurice Klee

Maurice M. Klee, Ph.D.
Reg. No. 30,399
Attorney for Applicant
1951 Burr Street
Fairfield, CT 06824
(203) 255-1400

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[305] Atty Dkt: ADP-231 US (SP05-073)

MAIL STOP AF- PATENT
Response Under
37 CFR §1.116
Expedited Procedure
Examining Group 1793

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO FINAL REJECTION

This is in response to the final Office Action dated November 28, 2008. In that Office Action, the Examiner rejected applicant's Claims 1-17 as allegedly unpatentable under 35 U.S.C. 103(a) over Chacon et al., U.S. Patent No. 6,831,029 (Chacon), in view of Narita et al., U.S. Patent No. 6,468,933 (Narita).

In particular, the Examiner noted that various of the claims of the present application have ranges that overlap with those disclosed in the Chacon patent and cited Section 2144.05 of the MPEP for the proposition that overlapping ranges can establish a *prima facie* case of obviousness. The Examiner cited Narita for its disclosure of the use of a combination of tin oxide and chloride in place of arsenic oxide as a fining agent for liquid crystal display glasses. The Examiner acknowledged that "Chacon et al. fail to teach any specific examples that are read directly on the instant claims..." (11/28/08

Office Action at page 5.) Although not explicitly stated in the Office Action, the same is true of Narita, i.e., applicant's claims do not read on Narita.[1]

Under the heading "Rebuttal of *Prima Facie* Case of Obviousness," Section 2144.05 of the MPEP states in relevant part:

> Applicants can rebut a *prima facie* case of obviousness based on overlapping ranges by showing the criticality of the claimed range. "The law is replete with cases in which the difference between the claimed invention and the prior art is some range or other variable within the claims. . . . In such a situation, the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range." *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990)....

Applicant respectfully submits that this is such a case. Submitted herewith is the Declaration of Adam J. Ellison Under 37 C.F.R. §1.132 (the Ellison Declaration), which discusses the criticality of applicant's MgO and RO/Al_2O_3 limitations with regard to tin fining and, in particular, the unexpected and abrupt increase in the number of blisters that arises when the RO/Al_2O_3 ratio drops below 1.00, even by a small amount.

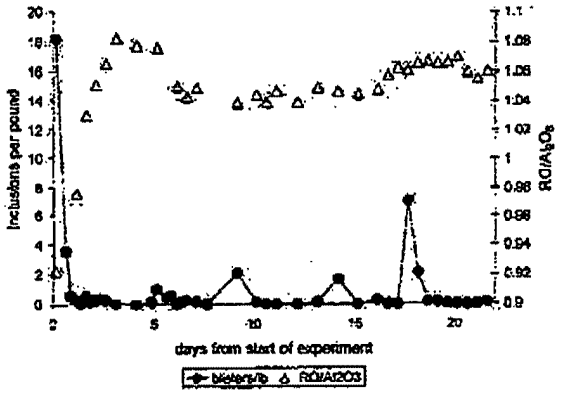
As explained in his declaration, Dr. Ellison is one of the inventors of the Chacon patent and the work of the present application was performed to improve the glasses of that patent. In particular, Dr. Ellison was seeking glasses that could be fined using tin oxide and still had the strain point, CTE, and density properties desired by manufacturers of liquid crystal displays and a liquidus viscosity greater than or equal to 100,000 poises so that the glass could be manufactured by, for example, the fusion process.

---

[1] On pages 3-4 of the Office Action, the Examiner summarized various of the limitations of applicant's claims. The claims, of course, speak for themselves. However, applicant would like to note that there are a number of errors in the summary. For example, independent Claim 9's ranges are not the same as those of independent Claim 1 and the summaries use "<" symbols where applicant's claims use "≤" symbols or the equivalent in words. Also, applicant's Claim 1 specifies that the concentration of tin oxide is greater than or equal to 0.01 mole percent, not less than 0.01 mole percent. In addition, at various places, the Office Action refers to the Dumbaugh patent, which applicant has assumed should be references to the Chacon patent.

In the course of his work, Dr. Ellison found that in order to use tin fining it was critical that the glass have both a MgO content greater than or equal to 1.0 mole percent and a RO/Al_2O_3 ratio greater than or equal to 1.00. The importance of this combination of compositional properties was not recognized when the work underlying the Chacon patent was performed and none of the 32 examples of that patent have both these properties. In particular, only two of the 32 examples of the Chacon patent use more than 1.0 mol% MgO (Examples 8 and 21) and those examples have a RO/Al_2O_3 ratio below 1.00 and do not use tin fining.

The importance of having the glass' MgO content greater than or equal to 1.0 mole percent is discussed at, for example, paragraphs [0085] - [0088] of applicant's published application. The effect of the RO/Al_2O_3 ratio on inclusions (blisters) during tin fining is illustrated in applicant's Figure 3, a copy of which is reproduced below.

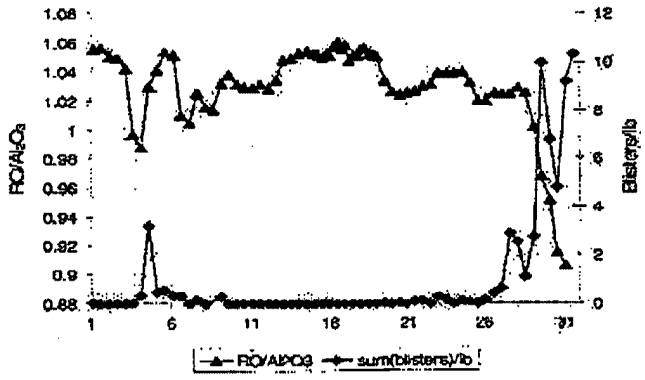


As can be seen in this figure, as the RO/Al_2O_3 ratio rises through 1.00 (see the triangular data points), the number of blisters/pound drops precipitously (see the circular data points). However, an examination of Figure 3 reveals that it only has a few data points close to the 1.00 value for the RO/Al_2O_3 ratio. The Ellison Declaration provides additional data that demonstrates the sensitivity of tin fining to the 1.00 value of the RO/Al_2O_3 ratio.

In particular, the experiments reported in the Ellison Declaration show that a RO/Al_2O_3 ratio of 1.00 is the cutoff for successful tin fining. Specifically, those experiments show that a RO/Al_2O_3 ratio of 1.00 or above leads to successful tin fining (assuming $MgO \geq 1.0$), while a RO/Al_2O_3 ratio below 1.00 does not work, in that the number of blisters per pound in the glass rises to commercially unacceptable levels.

The experiments reported in Dr. Ellison's Declaration were performed using the techniques and equipment, i.e., the laboratory scale melter, described in paragraph [0107] of applicant's published application. The glass' base composition was that of Example 24. The fining agent was tin oxide and neither arsenic nor antimony were used. The experiments preceded those of Figure 3 and had originally been designed to test the effects of varying the relative amounts of the alkaline earth oxides in the glass, while holding the sum of those oxides constant. However, through a batching error, the same amount of SrO was used in all of the experiments, which meant that for some of the compositions, the RO/Al_2O_3 dropped below 1.00.

The following is a copy of Exhibit A to the Ellison Declaration, where the horizontal axis shows the day of the experiment, the left hand vertical axis and the triangular data points show RO/Al_2O_3 ratios, and the right hand vertical axis and the diamond data points show blister levels.



The sensitivity of the blister level to the RO/Al_2O_3 ratio is immediately evident from this graph, as is the criticality of the 1.00 value. When the RO/Al_2O_3 dropped below 1.00, even by just a hundredth, the blister level immediately jumped up, e.g., to levels of 2 blisters/pound and above. As known in the art, such blister levels are commercially unacceptable for the production of large substrates for liquid crystal displays.

As quoted above, the MPEP acknowledges that "[a]pplicants can rebut a *prima facie* case of obviousness based on overlapping ranges by showing the criticality of the claimed range." Applicant respectfully submits that the data of Figure 3 and Exhibit A satisfy this standard in that they demonstrate that commercial practice of tin fining for glasses having a MgO content greater than or equal to 1.0 mole percent, requires a RO/Al_2O_3 ratio greater than or equal to 1.00. Neither the Chacon patent nor the Narita patent contains any disclosure of this critical requirement for the successful practice of tin fining. Accordingly, applicant believes that the Examiner's rejection under Section 103 has been overcome and should be withdrawn.

In view of the foregoing, applicant believes that this application is in condition for allowance. Accordingly, reconsideration and the issuance of a Notice of Allowance are respectfully requested.[2]

Respectfully submitted,

Date: 3/30/09

Maurice Klee

Maurice M. Klee, Ph.D.
Reg. No. 30,399
Attorney for Applicant
1951 Burr Street
Fairfield, CT 06824
(203) 255-1400

[2] Submitted herewith is a petition under 37 CFR §1.136 requesting a one month extension in which to file this response. With the extension, this paper is due on March 30, 2009. No further extension of time is believed to be necessary, but if such an extension is required, applicant requests that this be considered a petition therefor. The Director is hereby authorized to charge any fees which may be required for such an extension to Deposit Account No. 11-1158.

[305] Atty Dkt: ADP-231 US (SP05-073)

MAIL STOP AF-PATENT
Response Under
37 CFR §1.116
Expedited Procedure
Examining Group 1793

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

DECLARATION OF ADAM J. ELLISON UNDER 37 C.F.R. §1.132

I, Adam J. Ellison, declare as follows:

1. I am a Senior Research Associate in the Glass Research Department at Corning Incorporated (Corning). My education and experience in the field of glass technology is as follows. I received a bachelor's degree in geology chemistry from Occidental College in 1983 and Masters and Ph.D. degrees from Brown University in geological sciences in 1985 and 1988, respectively. I did post-doctoral research at Princeton University from 1988-1991 and worked in the Materials Science and Chemical Technology Division of the Argonne National Laboratory from 1994-1996. In 1996, I joined the Glass Research Department at Corning, where I have been since that date. My work has involved glasses of various types, including glasses for liquid crystal displays (LCDs), which I have worked on since first joining Corning.

2. I am the inventor of the above-identified application. I understand that in an Office Action dated November 28, 2008, the pending claims of the application were rejected for alleged obviousness based on Chacon et al., U.S. Patent No. 6,831,029 (Chacon), in view of Narita et al., U.S. Patent No. 6,468,933 (Narita). I am one of the inventors of the Chacon patent and the work of the present application was performed to improve the glasses of that patent. In particular, I was seeking glasses that could be

fined using tin oxide and still had the strain point, CTE, and density properties desired by manufacturers of liquid crystal displays and a liquidus viscosity greater than or equal to 100,000 poises so that the glass could be manufactured by, for example, the fusion process.

3. In the course of my work, I found that in order to use tin fining it was critical that the glass have both a MgO content greater than or equal to 1.0 mole percent and a RO/Al_2O_3 ratio greater than or equal to 1.00, where Al_2O_3 is the mole percent of Al_2O_3 and RO is the sum of the mole percents of MgO, CaO, SrO, and BaO in the glass. The importance of this combination of compositional properties was not recognized when the work underlying the Chacon patent was performed and none of the 32 examples of that patent have both these properties.

4. The importance of having the MgO content greater than or equal to 1.0 mole percent is discussed at, for example, paragraphs [0085] - [0088] of my published application. FIG. 3 of my application shows the effect of the RO/Al_2O_3 ratio on inclusions (blisters) during tin fining. That figure only has a few data points close to the 1.00 value for this ratio. I make this declaration to provide additional data that demonstrates the sensitivity of tin fining to the 1.00 value of the RO/Al_2O_3 ratio.

5. In particular, I make this declaration to report on experiments conducted at Corning under my direction and supervision which demonstrate that a RO/Al_2O_3 ratio of 1.00 is the cutoff for successful tin fining. These experiments show that a RO/Al_2O_3 ratio of 1.00 or above leads to successful tin fining (assuming $MgO \geq 1.0$), while a RO/Al_2O_3 ratio below 1.00 does not work, in that the number of blisters per pound in the glass rises to commercially unacceptable levels.

6. The experiments were performed before those of FIG. 3 of my application, using the techniques and equipment, i.e., the laboratory scale melter, described in paragraph [0107] of the application. The glass' base composition was that of Example 24. The tin oxide concentration was 0.07 mole percent (0.14 wt%). Neither arsenic nor antimony were used. The experiments were conducted over a 31 day period and had originally been designed to test the effects of varying the relative amounts of

the alkaline earth oxides in the glass, while holding the sum of those oxides constant. However, through a batching error, the same amount of SrO was used in all of the experiments, which meant that for some of the compositions, the RO/Al_2O_3 dropped below 1.00.

7. Attached as Exhibit A is a graph of the data obtained from these experiments, where the horizontal axis shows the day of the experiment, the left hand vertical axis and the triangular data points show RO/Al_2O_3 ratios, and the right hand vertical axis and the diamond data points show blister levels.

8. The sensitivity of the blister level to the RO/Al_2O_3 ratio is immediately evident from this graph, as is the criticality of the 1.00 value. When the RO/Al_2O_3 dropped below 1.00, even by just a hundredth, the blister level immediately jumped up, e.g., to levels of 2 blisters/pound and above. As known in the art, such blister levels are commercially unacceptable for the production of large substrates for liquid crystal displays.

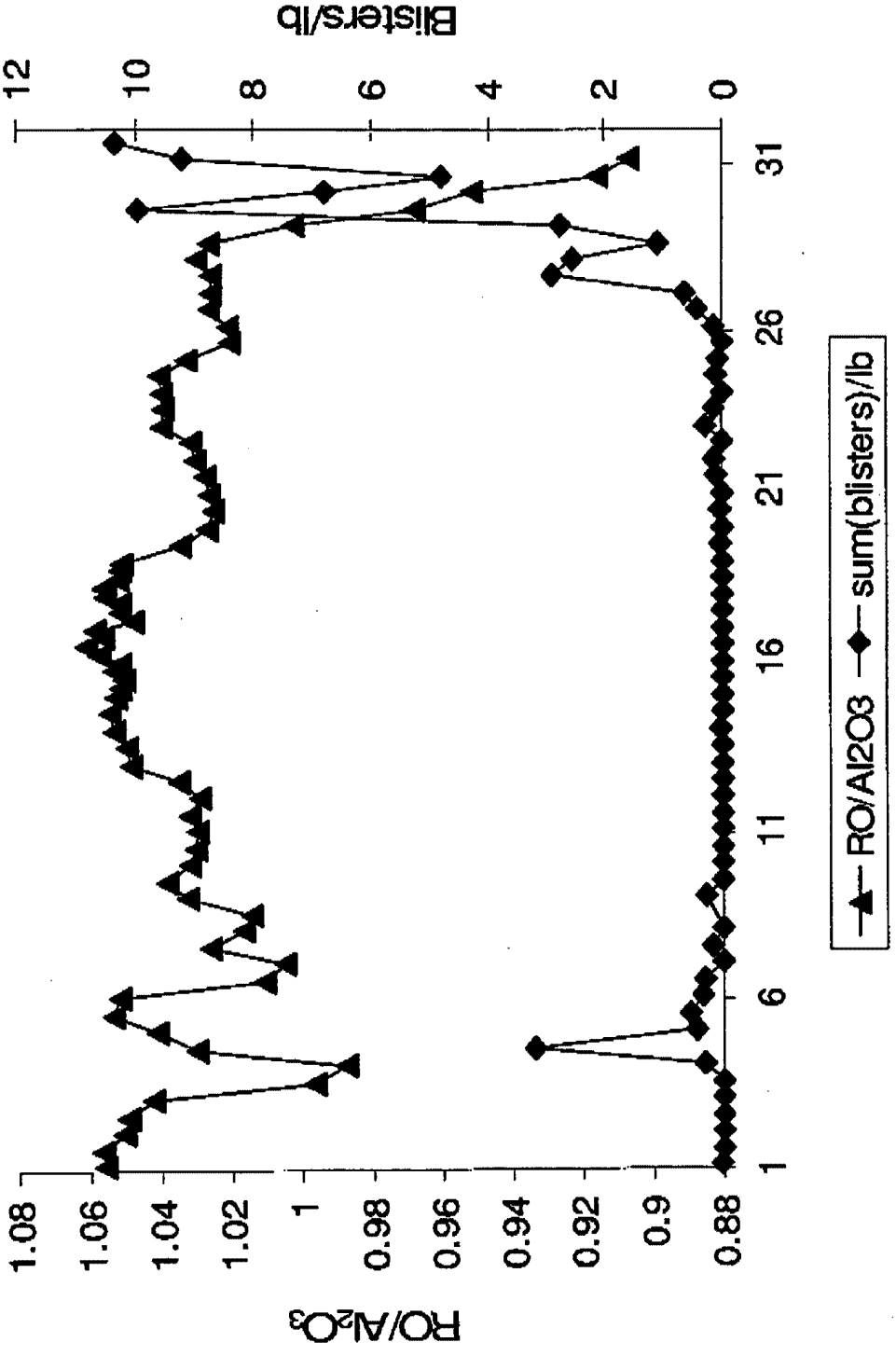
9. In summary, the data of Exhibit A demonstrates that commercial practice of tin fining for glasses having a MgO content greater than or equal to 1.0 mole percent, requires a RO/Al_2O_3 ratio greater than or equal to 1.00. Neither the Chacon patent nor the Narita patent contains any disclosure of this critical requirement for the successful practice of tin fining.

10. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

3/26/2009
(Date)

Adam J. Ellison

Exhibit A


Blisters/lb
12
10
8
6
4
2
0
RO/Al2O3
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
0.88
1
6
11
16
21
26
31
RO/Al2O3
sum(blisters)/lb

UNITED STATES PATENT AND TRADEMARK OFFICE

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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)	5778

22928 7590 05/04/2009

CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

EXAMINER	
HOBAN, MATTHEW E	

ART UNIT	PAPER NUMBER
1793	

DATE MAILED: 05/04/2009

Please find below and/or attached an Office communication concerning this application or proceeding.

The request for deferral/suspension of action under 37 CFR 1.103 has been approved.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

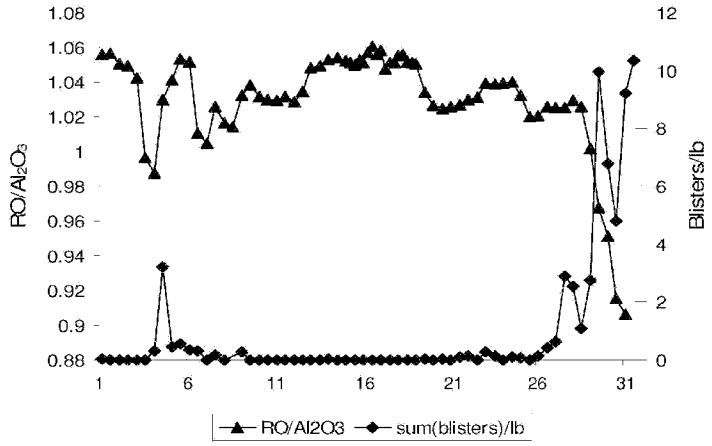
Applicant	:	Adam J. G. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

RESPONSE TO OFFICE ACTION AND ADVISORY ACTION

This is in further response to the Office Action dated November 28, 2008 and to the Advisory Action dated April 9, 2009.

In the November 28th Office Action, the Examiner rejected applicant's Claims 1-17 as allegedly unpatentable under 35 U.S.C. 103(a) over Chacon et al., U.S. Patent No. 6,831,029 (Chacon), in view of Narita et al., U.S. Patent No. 6,468,933 (Narita).

In response, applicant submitted a March 26, 2009 declaration from Dr. Adam Ellison which reported the results of historical experiments performed at Corning Incorporated (Corning), the assignee of this application, which along with Figure 3 of the application, demonstrate that a RO/Al_2O_3 ratio of 1.00 is the cutoff for successful tin fining. In particular, Dr. Ellison's March 26th declaration included the following graph which showed that when the RO/Al_2O_3 ratio drops below 1.00, even by just a hundredth, the blister level immediately jumps up to levels that are commercially unacceptable:



In the April 9th Advisory Action, the Examiner noted that applicant's showing was for glasses in which "only tin is used as a refining agent." The Examiner pointed out that "Narita states that when the amount of chloride is too low it is difficult to expel the gas from the glass," and then concluded that "removal of such inclusions when chloride is added...does not qualify as an unexpected result in as far as the claims are currently presented." In particular, the Examiner indicated that the rejection based on the Chacon/Narita combination would be maintained because the "criticality of the claimed range is not established."

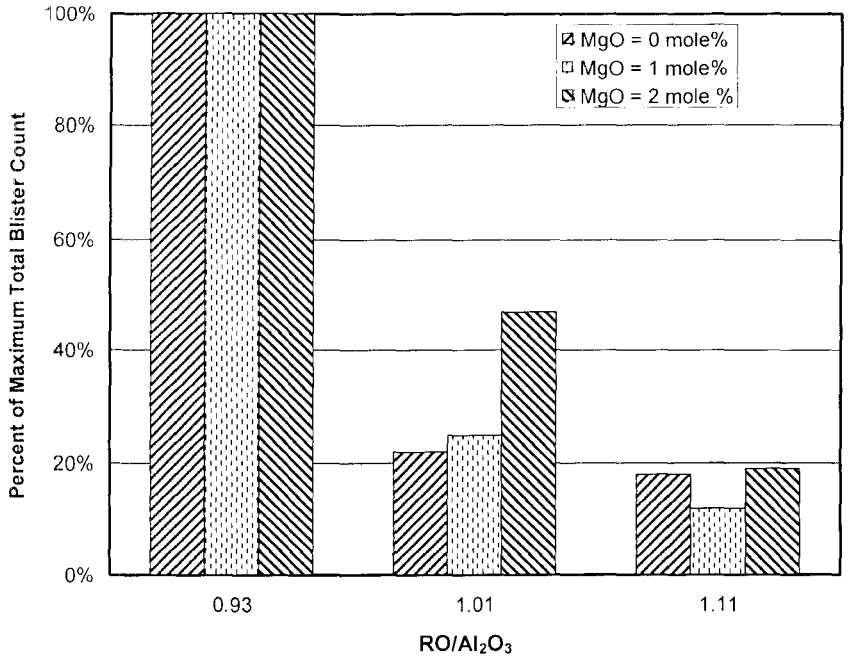
Submitted herewith is a supplemental declaration from Dr. Ellison which addresses the question of whether the criticality of having a RO/Al_2O_3 ratio greater than or equal to 1.00 is limited to cases where "only tin is used as a refining agent" or whether the criticality also applies to cases where tin is used in combination with halide fining. As reported in Dr. Ellison's supplemental declaration, the criticality of the claimed range applies both to tin fining when used alone and to tin fining when used in combination with halide fining.

As explained in the supplemental declaration, during the course of the development of the glasses of the present invention, Dr. Ellison performed a set of experiments which used tin plus halide fining (Ellison Supplemental Declaration, ¶4). Based on prior work with halide fining performed at Corning, Dr. Ellison used bromine in his halide experiments, rather than chlorine, because that prior work had shown that

bromine was a more effective fining agent than chlorine (Ellison Supplemental Declaration, ¶5).

The experiments reported in Dr. Ellison's supplemental declaration thus differ from the Narita patent in that they use bromine fining instead of chlorine fining. However, based on Corning's prior experience with the two halides, applicant submits that the experiments reported in Dr. Ellison's declaration are even a more stringent test of the question of whether the $RO/Al_2O_3 \geq 1.00$ limitation loses its criticality when tin fining is combined with halide fining. That is, if bromine fining does not eliminate the criticality, then chlorine fining should also not eliminate it, since chlorine fining is less effective than bromine fining.

The following is a copy of Exhibit C of Dr. Ellison's supplemental declaration which shows the effects of varying the RO/Al_2O_3 ratio for glasses employing both tin and halide fining. As discussed in the declaration, each of the glasses in these experiments had 0.07 mole percent SnO_2 and either 1.04 wt.% (Examples 1-5 and 7) or 1.07 wt.% (Examples 6 and 8-9) bromine (Ellison Supplemental Declaration, ¶6.)



As is evident from this graph, the RO/Al_2O_3 ratio plays a critical role in blister reduction when a combination of tin and halide fining is used. Specifically, as shown in this figure, RO/Al_2O_3 ratios of 1.01 and above are associated with at least a 50% decrease in the total number of blisters.

Applicant thus submits that the Examiner's statement in the Advisory Action that in Dr. Ellison's original declaration the "criticality of the claimed range is not established" for tin fining in combination with halide fining has now been addressed. Put simply, having a RO/Al_2O_3 ratio greater than or equal to 1.00 is critical for successful fining whether the fining is performed using tin fining alone or tin fining in combination with halide fining.

Because neither Chacon nor Narita, whether taken alone or in combination, discloses or suggests this discovery, applicant respectfully submits that his claims are not obvious in view of the cited art. Accordingly, reconsideration and the issuance of notice of allowance for the application are respectfully requested.

Respectfully submitted,

Date: 7/24/09

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[309] Atty Dkt: ADP-231 US (SP05-073)

MAIL STOP AF- PATENT
Response Under
37 CFR §1.116
Expedited Procedure
Examining Group 1793

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

SUPPLEMENTAL DECLARATION OF
ADAM J. ELLISON UNDER 37 C.F.R. §1.132

I, Adam J. Ellison, declare as follows:

1. I am the Adam J. Ellison who previously submitted a declaration dated March 26, 2009 in this application. My education and employment experience in the field of glass chemistry, including my work at Corning Incorporated (Corning), the assignee of this application, is set forth in my prior declaration.

2. I have read the Advisory Action for this application dated April 9, 2009. I make this supplemental declaration in response to the Examiner's observation in the Advisory Action that the data of my March 26th declaration is for glasses that used tin fining, rather than a combination of tin and chlorine fining as in Narita et al., U.S. Patent No. 6,468,933. In particular, I make this declaration to address the Examiner's comment that the "criticality of the claimed range is not established" because chlorine had not been used.

3. As indicated in paragraph [0100] of my published application (U.S. Patent Publication No. 2006/0293162), the glasses of the present application can be fined using tin fining in combination with, among other things, halide fining. As also stated in that paragraph, maintaining a RO/Al_2O_3 ratio greater than or equal to 1.0, as well as a MgO concentration greater than or equal to 1.0 mole percent, makes fining based on tin in combination with other fining agents easier to perform and more effective.

4. At Corning, halide fining is not considered as desirable as non-halide fining because halides produce air pollution and equipment erosion. Also, some customers have limits on the amount of halide that can be present in LCD glasses. Nevertheless, in developing the glasses of the present application, some experiments were performed using tin fining in combination with halide fining. As set forth below, like the experiments reported in my March 26th declaration, those experiments showed that having a RO/Al_2O_3 ratio greater than or equal to 1.0 is critical to successful tin/halide fining.

5. The experiments I performed used bromine as the halide rather than chlorine, as in the Narita patent. I chose bromine because prior work at Corning had shown that bromine is a more effective fining agent for LCD glasses than chlorine. Specifically, compared to chlorine, less bromine is retained in the finished glass which is desirable since halide fining agents function by forming or contributing to the formation of bubbles which rise to the top of the molten glass and thus the more of the halide that is released (or, conversely, the less that is retained), the better. Also, the temperature range over which bromine is released from LCD glasses is better for fining than the temperature range over which chlorine is released.

6. A 3x3 set of experiments was performed using three MgO concentrations (0, 1, and 2 mole percent) and three RO/Al_2O_3 ratios (0.93, 1.01, and 1.11). The compositions of the nine examples are set forth in Exhibit A. The MgO was batched as periclase, i.e., MgO. Bromine was supplied by using calcium bromide to provide some of the glass' calcium, with the rest provided by limestone (calcium carbonate). Specifically, the bromine concentration was 1.04 wt.% of the starting batch for Examples 1-5 and 7, and 1.07 wt.% for Examples 6, 8 and 9. Exhibit A does not list bromine concentrations because bromine is released into the atmosphere as the glass is formed. For each of the MgO concentrations, the RO/Al_2O_3 ratio was varied by removing 0.5 wt.% or 1.0 wt.% Al_2O_3 and replacing it with CaO provided as calcium carbonate. As shown in Exhibit A, each of the examples had 0.07 mole percent SnO_2.

7. The melting procedure was as follows: 900 gram batches were loaded

into 650 cubic centimeter platinum crucibles in silica backers and packed into a pre-heated SiC glowbar furnace idling at 1600°C. The 1600°C value was chosen since it is approximately the temperature at which batches are melted in a commercial melter. After three hours at 1600°C, the crucibles were removed and the glasses were annealed within them. The three hour value was chosen because it represents a typical minimum residence time in a commercial melter. The annealed boules were core-drilled, and the core drills were cut into 2.5 x 1.0 x L centimeter prisms with one flat and one edge polished, where L is the length of the core drill. The prisms were analyzed for blister (seed) count at depths of 1, 3, 5, and 7 centimeters from the top (the scum layer) and for minimum and maximum blister size.

8. Exhibit B shows (a) the blister counts at the various depths for the nine examples, (b) the total number of blisters over all the depths, and (c) the minimum and maximum blister sizes in microns at the various depths. Because fining depends on the presence of large bubbles which rise quickly in the molten glass, large minimum and maximum blister sizes are better.

9. An examination of the data of Exhibit B shows that the glasses having 0 mole percent MgO had lower total numbers of blisters than those having 1 or 2 mole percent. This effect was a result of the procedure used in the experiments to increase the MgO concentration from 0 mole percent to 1 or 2 mole percent. As can be seen in Exhibit A, the MgO increase was accomplished by reducing CaO. Specifically, the amount of calcium carbonate in the batch used to prepare the glass was reduced. During melting, calcium carbonate gives off carbon dioxide. Accordingly, more carbon dioxide was released for the glasses having 0 mole percent MgO (i.e., the glasses having higher calcium carbonate levels) than those having 1 or 2 mole percent MgO (i.e., the glasses having lower calcium carbonate levels).

10. Although calcium carbonate gives off carbon dioxide as it is melted, calcium carbonate is not considered a fining agent in the art because it gives off carbon dioxide at too early a stage in the melting process and thus at most it produces bubbles which may continue to exist at later stages when fining actually takes place and the

carbon dioxide and other bubbles are cleared from the glass. However, because this set of experiments used bromine fining, the enhanced overall gas content resulting from the carbon dioxide produced better fining, i.e., the enhanced overall gas content produced lower total numbers of blisters for the glasses having a higher CaO content as a result of having a lower MgO content. As reported in the present application, in a commercial setting, higher concentrations of MgO, i.e., MgO concentrations greater than or equal to 1.0 mole percent, actually result in lower blister counts because the MgO lowers the viscosity of the molten glass in the finer and lower viscosities mean that bubbles can rise faster in the molten glass and thus enter the atmosphere from the glass. The changes in Al_2O_3 content also involved changes in the amount of calcium carbonate used in the batch, but as shown in Exhibit B, the effect due to the RO/Al_2O_3 ratio was greater than that which would have been predicted from the changes in carbonate levels.

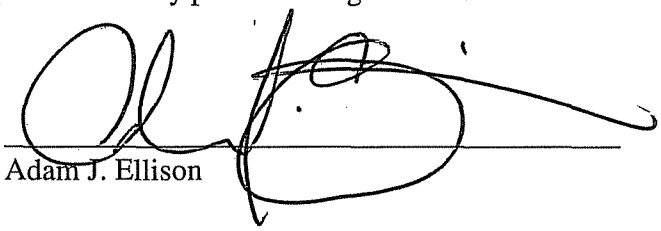
11. To isolate the effect of the RO/Al_2O_3 ratio from the MgO/CaO interaction, the total blister count data for a given MgO concentration was divided by the maximum total blister count seen for that MgO concentration. Thus, the total blister count values for Examples 1, 4, and 7 were divided by 49, the maximum number of total blisters for MgO equal to 0 mole percent; the values for Examples 2, 5, and 8 were divided by 102, the maximum number of total blisters for MgO equal to 1 mole percent; and the values for Examples 3, 6, and 9 were divided by 103, the maximum number of total blisters for MgO equal to 2 mole percent.

12. The results of this analysis are shown in Exhibit C. As is evident from this graph, just as in my March 26th declaration which used only tin fining, the RO/Al_2O_3 ratio plays a critical role in blister reduction when a combination of tin and halide fining is used. Specifically, as shown in this figure, RO/Al_2O_3 ratios of 1.01 and above were associated with at least a 50% decrease in the total number of blisters in all cases.

13. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false

statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

7/24/09
(Date)



Adam J. Ellison

Exhibit A

Compositions

(Mol %)	1	2	3	4	5	6	7	8	9
SiO_2	69.3	69.3	69.3	69.03	69.03	69.03	68.78	68.78	68.78
Al_2O_3	10.8	10.8	10.8	10.46	10.46	10.46	10.11	10.11	10.11
B_2O_3	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9
MgO	0	1	2	0	1	2	0	1	2
CaO (from $CaCO_3$)	9.1	8.1	7.1	9.71	8.71	7.71	10.31	9.31	8.31
CaO (from $CaBr_2$)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
SrO	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
SnO_2	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
RO/Al_2O_3	0.93	0.93	0.93	1.01	1.01	1.01	1.11	1.11	1.11

Exhibit B

Blister Counts

Depth	1	2	3	4	5	6	7	8	9
1 cm	16	27	36	2	10	6	4	6	7
3 cm	18	26	8	2	7	11	3	5	8
5 cm	8	22	11	2	6	15	1	1	3
7 cm	7	27	48	5	2	16	1	0	2
Total	49	102	103	11	25	48	9	12	20

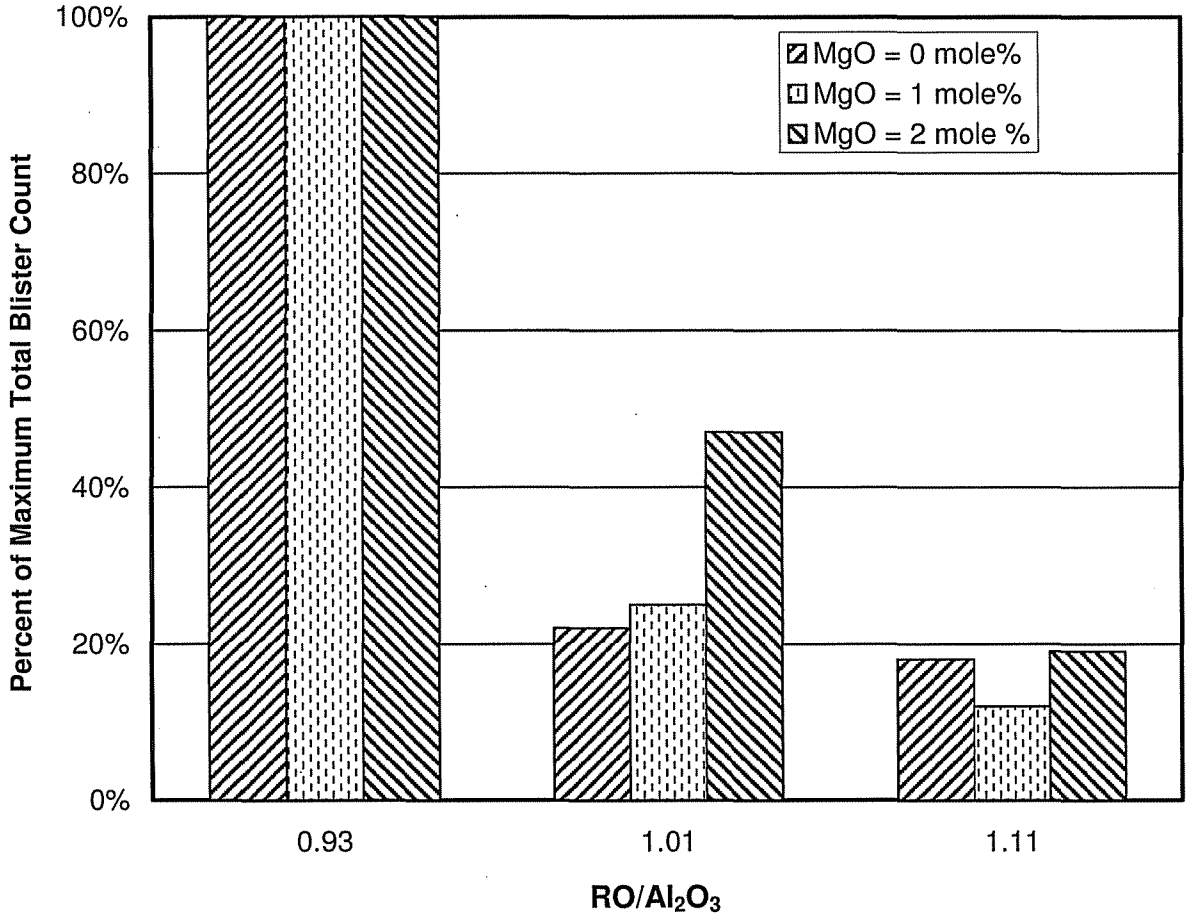
Maximum Blister Diameter

Depth	1	2	3	4	5	6	7	8	9
1 cm	526	643	497	643	146	380	351	526	439
3 cm	453	497	424	497	497	365	585	439	541
5 cm	380	468	278	409	365	322	526	322	380
7 cm	117	307	205	292	190	219	292	0	102

Minimum Blister Diameter

Depth	1	2	3	4	5	6	7	8	9
1 cm	102	44	29	497	497	292	73	88	161
3 cm	15	29	44	409	117	44	497	117	132
5 cm	15	15	73	73	102	29	526	322	175
7 cm	15	15	15	58	132	15	292	0	29

Exhibit C


100%
80%
60%
40%
20%
0%
Percent of Maximum Total Blister Count
MgO = 0 mole%
MgO = 1 mole%
MgO = 2 mole %
0.93
1.01
1.11
RO/Al2O3

Electronic Acknowledgement Receipt

EFS ID:	5766801
Application Number:	11478493
International Application Number:	
Confirmation Number:	5778
Title of Invention:	Fining of boroalumino silicate glasses
First Named Inventor/Applicant Name:	Adam J.G. Ellison
Customer Number:	22928
Filer:	Maurice M. Klee/Anya Klee
Filer Authorized By:	Maurice M. Klee
Attorney Docket Number:	ADP-231 (SP05-073)
Receipt Date:	24-JUL-2009
Filing Date:	28-JUN-2006
Time Stamp:	16:15:31
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	adp231_US_a_Response.pdf	313090 0b065959540b53904da7a296c51ed6987b69ee9e	no	4

Warnings:	
Information:	

2	Rule 130, 131 or 132 Affidavits	adp231_US_a_Suppl_Decl_of_Ellison.pdf	423646 d28737110cb3368911066e630641707bf58f9a11	no	11

Warnings:	
Information:	
Total Files Size (in bytes):	736736

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)	5778

22928 7590 10/13/2009

CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

EXAMINER	
HOBAN, MATTHEW E	
ART UNIT	PAPER NUMBER
1793	

MAIL DATE	DELIVERY MODE
10/13/2009	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	11/478,493	ELLISON, ADAM J.G.	
	Examiner	Art Unit	
	Matthew E. Hoban	1793	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *7/24/09*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) *18-20* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-17* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 7/24/09 has been entered.

Election/Restrictions

2. Claims 18-20 withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on 2/04/08.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

3. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 1-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chacon in 6831029 in view of Narita in 6,468,933.

Regarding Claims 1, 6 and 9 (COMPOSITION): These claims include language directed towards the major oxide components of the glass.

Chacon et al teach a similar glass for use as a substrate in flat panel display devices, where the composition has overlapping ranges with the composition of the instant claims 1, 6, and 9. These ranges can be found in column 3, line 38-41 of the patent.

Chacon et al. fail to teach any specific examples that read directly on the instant claims; however, overlapping ranges have been held to establish prima facie obviousness. The ranges of Chacon further are sufficiently close to the instant claims. One of ordinary skill in the art would have needed to only chosen from the portion of said overlapping range to arrive at the invention as claimed. See MPEP 2144.05.

Claim 6 of the instant claims serves to further adjust the SrO level in the glass to below 1 mol%; however, Chacon's range of SrO is inclusive of 0 mol% and teaches that SrO content as well as BaO content should be minimized because these oxides negatively affect the glass density.

Regarding Claims 1, 9, 10 (RO/AL2O3 ratio): These claims include language regarding the ratio of the sum of divalent metal oxides to aluminum oxide. These claims specify that the ratio between these two must be between 1 and 1.25.

It is clearly stated at Column 5, lines 18-25 that the ratio between RO and alumina in the glass composition is between .9 and 1.2 in this composition. This range reads on

the instantly claimed range, and therefore creates a prima facie case of obviousness. One of ordinary skill in the art would have needed to only chosen from the portion of said overlapping range to arrive at the invention as claimed. See MPEP 2144.05.

Regarding Claims 1-5, 9, 13-17 (FINING AGENTS): These claims include language regarding the fining agent added to the glass composition (or have dependant claims associated to them regarding this aspect)

The composition of Chacon teaches the use of conventional fining agents such as arsenic oxide, antimony, and tin (See Column 5, lines 35-45). These fining agents can be added in an amount of up to 1 mol%. The problem arises with Chacon's examples, which only show fining where antimony and arsenic are included with tin as fining agents. So, although Chacon does teach that tin is a possible fining agent, but doesn't teach its inclusion in a sufficient amount in the examples to make the claims obvious.

However, Narita does disclose the use of tin oxide as a replacement fining agent for arsenic oxide. In the background of the invention (Section (2) Prior Art in Column 1) Narita explains that alkali free glasses, such as the one that is the subject of the teachings, as well as those of Chacon, are typically used as a glass substrate for a liquid crystal display. An important aspect of these glasses is the creation of a glass without bubbles. This is done by adding fining agents, which generate a fining gas in the melt. This melting process is usually at a high temperature, due to the lack of alkali-

oxides, so the selection of a fining agent is dependant on this fact. Previously, arsenic oxide was used as a fining agent, but as is commonly known and also taught by Narita, arsenic oxide is very toxic and causes pollution. To solve this issue, Narita uses a Tin Oxide and Chloride instead of arsenic oxide (See Column 1, Lines 54-58). As can be seen in the examples as well as in Tables 2-5, tin oxide and chloride are added in an amount of .05-2 wt% and .005-1 wt% respectively. These figures in the context of Narita's specific examples generally translate to .025-1 mol% and .005-1 mol%, respectively. For example, composition 9 in Table 5 contains .9 wt% or .42 mol% tin oxide. As stated, Narita's compositions are substantially arsenic free, meaning they have less than .02 mol% Arsenic is present (See Column 3, Lines 56-60). Narita is silent as to the amount of antimony in the composition, but because tin oxide and chloride are the only fining agents, one of ordinary skill in the art would find it obvious that the amount of antimony would also be less than .05 mol%.

The fining agent of Narita, Tin Oxide and Chloride, could be directly incorporated into the composition of Chacon. Chacon states that a possible fining agent in the composition is arsenic oxide, where Narita teaches a range of fining agents as a replacement for arsenic oxide. Furthermore Chacon teaches the suitability of Cl and tin oxide individually but does not give enough specificity to allow one of ordinary skill in the art to attain a suitable level of fining. When combining these two references, only tin oxide and chloride would be used for fining in the same wt% as the teachings of Narita, whose teachings teach an amount of tin oxide greater than .01 mole percent, with no

antimony oxide or arsenic oxide. This combination of fining agents makes obvious all fining characteristics found in claims 1-5 and 13-17.

The combination of these teachings would produce less toxic gas during manufacturing, which would have been obvious motivation for one of ordinary skill in the art at the time the invention was made. Furthermore, these two fining agents (arsenic and tin oxide) according to Narita perform entirely the same function, meaning that they are generally interchangeable and create no unexpected results.

Regarding Claims 7 and 11: These claims are directed towards the density of the glass, which must be less than 2.41 g/cc

The glass of Chacon is stated as having a density less than about 2.4 g/cc (See Column 4, Lines 15-25). The glasses of Chacon in view of Narita would also have a similar density, since the change in fining agents would not dramatically impact the final density of the glass.

Regarding Claims 8 and 12: Chacon teaches a glass having all of these properties as can be seen in Column 4, Lines 15-45. The glass must have a strain point greater than 660C, a CTE of between 28 and 33E-7 and a liquidus viscosity of greater than about 200,000 poises.

1. Claims 1-2, 4-5, and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa in 6169047.

Regarding Claim 1: Nishizawa teaches in Example 29 a glass composition having in mol%, 67% SiO_2. 12% Al_2O_3, 7% B_2O_3, 3% MgO, 9% CaO, 2% SrO. This composition has an MO/Al_2O_3 value of 1.167.

When teaching this composition, Nishizawa is silent as to the fining agents used in creating it.

However, in Column 4, lines, 30-35, Nishizawa specifically states that a total amount of at most 5 mol% of SnO_2 can be used as a fining agent. It would have been obvious to use tin oxide as a fining agent as Nishizawa expressly states use of these compounds. One would be motivated to use tin oxide, as it increases the clarity of the glass, which is stated by Nishizawa (See Column 4, Lines 30-35).

Regarding Claim 2, 4-5: Nishizawa does not include these components and specifically states that they should not be included as they are toxic (See Column 4, Lines 35-40)

Regarding Claim 8: The glass of Nishizawa has a strain point of 680 degrees (See Table 4).

Double Patenting

2. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

3. Claims 1-2, 4-17 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-7 and 11-12 of U.S. Patent No. 7534734. Although the conflicting claims are not identical, they are not patentably distinct from each other because the claims are to the exact same range of compositions having a ratio between RO and Al_2O_3 greater than 1, and also having the same properties as those seen in claims 7-8 and 11-12.

Response to Arguments

Applicant's arguments filed 7/24/2009 have been fully considered but they are not persuasive. Applicant's submission of the Affidavit signed by Dr. Ellison as of 7/24/09 is noted. This declaration is ineffective as it still fails to factually establish the use of Chlorine as a fining agent. The declaration makes broad statements as to Bromine being a better fining agent than Chlorine, where none of these statements are supported. The declaration speaks of prior work done at Corning on similar glass showing the use of both chlorine and bromine as fining agents. The inclusion of such tests in the declaration would concretely show the relationship between bromine and chlorine as fining agents without comparing them in general unsupported terms. Statements supported by said data would therefore be able to relate the prior art to the alleged unexpected results. If the statements submitted in the declaration were properly supported by the above mentioned data, the declaration would successfully show unexpected results based solely on the ratio of alkaline earth oxides to aluminum oxide and the magnesium oxide amount added thereto. At the current juncture, it is still unclear whether the 'unexpected results' are attributable to the difference in halide gases used and not to the ratio/MgO amount used, as it is stated that the use of Cl as a fining agent eliminates the fine bubbles (blisters) in the melt.

Applicant's Affidavit submitted on 4/28/2009 is acknowledged. As was discussed previously, this declaration fails to acknowledge the effects of the halide fining agent in the glass and therefore does not establish that the results are unexpected based on the claimed subject matter. Furthermore, the declaration submits the criticality of MgO, but

this relationship was never established factually. This second problem has been corrected with the submission of the most recent declaration.

Applicant's arguments hinge on the declaration submitted on 7/24/09 as is discussed above. As the declaration does not prove unexpected results, the arguments are meritless.

. For these reasons the previously presented 103 rejection over Chacon in view of Narita is maintained.

Conclusion

1. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. 6537937.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew E. Hoban whose telephone number is (571) 270-3585. The examiner can normally be reached on Monday - Friday from 7:30 AM to 5 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jerry Lorengo can be reached on (571) 272-1233. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/C. Melissa Koslow/
Primary Examiner, Art Unit 1793

/Matthew E Hoban/
Examiner, Art Unit 1793

Notice of References Cited	Application/Control No. 11/478,493	Applicant(s)/Patent Under Reexamination ELLISON, ADAM J.G.	
	Examiner Matthew E. Hoban	Art Unit 1793	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,169,047	01-2001	Nishizawa et al.	501/66
*	B	US-6,537,937	03-2003	Nishizawa et al.	501/66
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11478493	ELLISON, ADAM J.G.
	Examiner	Art Unit
	Matthew E Hoban	1793

SEARCHED

Class	Subclass	Date	Examiner
501	+text	3/20/2008	meh
501	66	10/07/09	mh

SEARCH NOTES

Search Notes	Date	Examiner
See East Search History	3/20/2008	meh
Inventor Search Completed through PALM	3/20/2008	meh
See EAST search history	11/24/2008	mh
Consulted with Jerry Lorengo regarding Declaration	10/07/09	mh
Consulted with Lizz Bolden regarding Declaration	10/07/09	mh
Updated East Search	10/07/09	mh

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L3	21	("4824808" | "4994415" | "5244847" | "5348916" | "5374595" | "5387560" | "5459109" | "5489558" | "5506180" | "5508237").PN. OR ("5801109").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 14:19
L4	16	("5244847" | "5348916" | "5801109" | "5885914").PN. OR ("6169047").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 14:50
L5	7	("20020032117" | "5851939" | "6060168" | "6169047" | "6417124" | "6465381").PN. OR ("6881692").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 14:56
L6	29	("2231811" | "2961328" | "3338696" | "3682609" | "4394453" | "4824808" | "5116788" | "5244847" | "5374595" | "5506180" | "5508237" | "5770535" | "5801109" | "5811361" | "5851939" | "5885914" | "6060168" | "6096670" | "6169047" | "6250111" | "6319867" | "6468933").PN. OR ("6831029").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 14:58
L7	24	("3847627" | "3978362" | "4180618" | "4255198" | "5116788" | "5116789").PN. OR ("5244847").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 15:03

L8	30	("2961328" | "4394453" | "4634683" | "4634684" | "4666868" | "4666869" | "5116787" | "5116788" | "5116789" | "5326730" | "5374595" | "5489558" | "5508237" | "5741746").PN. OR ("6060168").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 15:09
L9	15	("20010034293" | "3338696" | "3682609" | "5374595" | "5459109" | "5801109" | "6060168" | "6319867" | "6417124" | "6468933" | "6508083" | "6537937" | "6664203").PN. OR ("6992030").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 15:13
L10	21	("3496401" | "3798491" | "3978362" | "4060423" | "4255198" | "4302250").PN. OR ("4394453").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 15:21
L11	39	(L7 L8 L9 L10) not (L6 L5 L4)	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 15:23
L12	35	(L7 L8 L9 L10) not (L6 L5 L4 L3)	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 15:23
L13	10	"5831029"	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 16:06
L14	6	"6831029"	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 16:06
L15	20	"6468933"	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 16:06
L16	6	"6831029"	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 16:27
L17	1	"7534734"	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 16:46

L19	1296	501/66.ccls.	US-PGPUB; USPAT; USOCR	OR	ON	2009/10/07 17:01
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S45	6	free same toxic same ("Sb.sub.2O.sub.3" or "Sb.sub.2 O.sub.3" antimony) same (Arsenic "As.sub.2O. sub.3" "As.sub.2 O. sub.3") and (tin "SnO. sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:07
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10/7/2009 5:02:24 PM
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE

This is in response to the Office Action dated October 13, 2009. In that Office Action, the Examiner repeated his prior rejection of Claims 1-17 as allegedly unpatentable under 35 U.S.C. 103(a) over Chacon et al., U.S. Patent No. 6,831,029 (Chacon), in view of Narita et al., U.S. Patent No. 6,468,933 (Narita).

The Chacon/Narita rejection of the claims of this application was first made in a final Office Action dated November 28, 2008. In response, applicant submitted a March 26, 2009 declaration which reported the results of historical experiments performed at Corning which, along with Figure 3 of this application, demonstrate that a RO/Al_2O_3 ratio of 1.00 is the cutoff for successful tin fining. In particular, the March 26th declaration showed that when the RO/Al_2O_3 ratio drops below 1.00, even by just a hundredth, the blister level immediately jumps up to levels that are commercially unacceptable.

In an April 9, 2009 Advisory Action, the Examiner noted that applicant's showing was for glasses in which "only tin is used as a refining agent." The Examiner pointed out that "Narita states that when the amount of chloride is too low it is difficult

to expel the gas from the glass," and then wrote that "removal of such inclusions when chloride is added...does not qualify as an unexpected result in as far as the claims are currently presented." In particular, the Examiner indicated that the rejection based on the Chacon/Narita combination would be maintained because the "criticality of the claimed range is not established."

In response to these comments, applicant submitted a July 24, 2009 supplemental declaration which addressed the question of whether the criticality of having an RO/Al_2O_3 ratio greater than or equal to 1.00 is limited to cases where "only tin is used as a refining agent" or whether the criticality also applies to cases where tin is used in combination with halide fining. As reported in the supplemental declaration, the criticality of the claimed range applies both to tin fining when used alone and to tin fining when used in combination with halide fining.

In the present Office Action, the Examiner stated the following with regard to applicant's July 24th supplemental declaration:

> Applicants' arguments filed 7/24/09 have been fully considered but they are not persuasive. Applicant's submission of the Affidavit signed by Dr. Ellison as of 7/24/09 is noted. This declaration is ineffective as it still fails to factually establish the use of Chlorine as a fining agent. The declaration makes broad statements as to Bromine being a better fining agent than Chlorine, where none of these statements are supported. The declaration speaks of prior work done at Corning on similar glass showing the use of both chlorine and bromine as fining agents. The inclusion of such tests in the declaration would concretely show the relationship between bromine and chlorine as fining agents without comparing them in general unsupported terms. Statements supported by said data would therefore be able to relate the prior art to the alleged unexpected results. If the statements submitted in the declaration were properly supported by the above mentioned data, the declaration would successfully show unexpected results based solely on the ratio of alkaline earth oxides to aluminum oxide and the magnesium oxide amount added thereto. At the current juncture, it is still unclear whether the 'unexpected results' are attributable to the difference in halide gases used and not to the ratio/MgO amount used, as it is stated that the use of Cl as a fining agent eliminates the fine bubbles (blisters) in the melt. (10/13/09 Office Action at page 10; emphasis in original)

Submitted herewith is a further declaration from Dr. Ellison dated January 8, 2010, which sets forth the data requested by the Examiner in the October 13th Office

Action. Specifically, the declaration and its Exhibit A set forth data developed at Corning in the 1990's which shows that bromine is a better fining agent than chlorine for LCD glasses. The following is a copy of the table of paragraph 6 of the declaration. The numbers in this table are average numbers of seeds in seeds/cubic inch found in crucible melts of an LCD glass which was fined using the fining agents of the first row of the table.

0.5%Br	0.5%Br+SnO	0.5%Cl	1.0%Cl	0.5%Cl+SnO
8670	203	21,400	91,700	26,500

As this data shows, bromine is clearly superior to chlorine as a fining agent for LCD glasses, whether used alone or in combination with tin. Based on this data, it is evident that the tin+bromine fining of the experiments described in applicant's July 24th declaration was a more stringent test of criticality than tin+chlorine fining, i.e., Narita fining, would have been. Accordingly, applicant respectfully submits that the Examiner's query in the October 13th Office Action as to the source of the unexpected results has been fully met -- the unexpected results come from applicant's invention, not from a "difference in halide gases used."

In addition to the Chacon/Narita rejection, the Examiner also rejected Claims 1-2, 4-5, and 8 under 35 U.S.C. 103(a) based on Nishizawa et al., U.S. Patent No. 6,169,047 (Nishizawa). In particular, the Examiner relied on the mole percent values for Example 29 of Nishizawa's Table 9. Applicant respectfully submits that those mole percent values cannot be relied upon. Attached hereto as Exhibit A is a transformation to mole percent of the weight percent values for Example 29 given in Nishizawa's Table 4. As shown in this exhibit, Nishizawa's Table 9 mole % values for Example 29 do not correspond to the Table 4 weight % values. In particular, the mole percent values of Exhibit A and Table 9 are substantially different for SiO_2 and, importantly, for Al_2O_3. As a result, the RO/Al_2O_3 ratio for Example 29 is 1.308, which is outside of applicant's claimed range.

More generally, as acknowledged by the Examiner in the October 13th Office Action, "Nishizawa is silent as to the fining agent used in creating" Example 29. Nishizawa does state at column 4, lines 30-34, that "[i]n the glass of the present invention, in addition to the above components, ZnO, SO_3, F, Cl and SnO_2 may be incorporated in a total amount of at most 5 mol %, in order to improve the melting property, the clarity and the forming property of the glass." Applicant respectfully submits that this general statement, with no specific amounts for any of the five listed components, would not lead a person of ordinary skill in the art to the present invention and certainly would not lead such a person to the RO/Al_2O_3 ratios and MgO concentrations which applicant found are critical to successful tin fining. Applicant notes that Chacon also mentions SnO_2 as a possible component but as acknowledged by the Examiner, Chacon "doesn't teach its inclusion in a sufficient amount in the examples to make the claims obvious." The same is also true of Nishizawa. Accordingly, as with Chacon, the obviousness rejection based on Nishizawa should be withdrawn.

In addition to the foregoing, in the October 13th Office Action, the Examiner also made an obviousness-type double patenting rejection based on Dr. Ellison's later-filed U.S. Patent No. 7,534,734. In making this rejection, the Examiner asserted that Claims 1-2 and 4-17 of this application are to "the exact same range of compositions" as Claims 1-7 and 11-12 of the '734 patent. Applicant respectfully disagrees. Among other things, each of the claims of the '734 patent requires that the glass has an Fe_2O_3 content in the range of 0.010-0.033 mole percent. The claims of this application contain no such limitation. Moreover, the published version of this application, i.e., U.S. Patent Publication No. 2006/0293162, was one of the references specifically made of record by the examiner of the '734 patent.

In discussing obviousness-type double patenting rejections, the MPEP distinguishes between domination and double patenting as follows:

> Domination and double patenting should not be confused. They are two separate issues. One patent or application "dominates" a second patent or application when the first patent or application has a broad or generic claim which fully encompasses or reads on an invention defined

> in a narrower or more specific claim in another patent or application. Domination by itself, i.e., in the absence of statutory or nonstatutory double patenting grounds, cannot support a double patenting rejection. *In re Kaplan*, 789 F.2d 1574, 1577-78, 229 USPQ 678, 681 (Fed. Cir. 1986); and *In re Sarrett*, 327 F.2d 1005, 1014-15, 140 USPQ 474, 482 (CCPA 1964). However, the presence of domination does not preclude double patenting. See, e.g., *In re Schneller*, 397 F.2d 350, 158 USPQ 210 (CCPA 1968). (MPEP at §804(II).)

Applicant submits that under this guidance, the obviousness-type double patenting rejection of the October 13th Office Action is not well-founded and should be withdrawn.

Based on the foregoing, applicant believes that this application is now in condition for allowance.[1] Accordingly, reconsideration and the issuance of a Notice of Allowance for the application are respectfully requested.

Respectfully submitted,

Date: 1/13/10

Maurice Klee

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Reg. No. 30,399
Attorney for Applicant
1951 Burr Street
Fairfield, CT 06824
(203) 255-1400

[1] No extension of time is believed to be necessary for the filing of this Response, but if such an extension of time is required, applicant requests that this be considered a petition therefor. The Director is hereby authorized to charge any fees which may be required for such an extension to Deposit Account No. 11-1158.

Exhibit A

Component	Molecular Weight	Wt.%	# of Moles (Wt.%/MW)	Mole% (# of Moles/TotalMoles)*100
SiO_2	60.084000	61.3	1.0202	67.914
Al_2O_3	101.961276	16.6	0.1628	10.837
B_2O_3	69.620200	7.4	0.1063	7.076
MgO	40.304400	1.8	0.0447	2.976
CaO	56.077400	7.7	0.1373	9.140
SrO	103.619400	3.2	0.0309	2.057
BaO	153.326400	0.0	0.0000	0.000
		totalmoles =	1.5022	

[315] Atty Dkt: ADP-231 US (SP05-073)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

SUPPLEMENTAL DECLARATION OF
ADAM J. ELLISON UNDER 37 C.F.R. §1.132

I, Adam J. Ellison, declare as follows:

1. I am the Adam J. Ellison who previously submitted declarations dated March 26, 2009 and July 24, 2009 in this application. My education and employment experience in the field of glass chemistry, including my work at Corning Incorporated (Corning), the assignee of this application, is set forth in my March 26, 2009 declaration.

2. I have read the Office Action for this application dated October 13, 2009. I make this supplemental declaration in response to the following comments by the Examiner which appear on page 10 of the Office Action:

> Applicants' arguments filed 7/24/09 have been fully considered but they are not persuasive. Applicant's submission of the Affidavit signed by Dr. Ellison as of 7/24/09 is noted. This declaration is ineffective as it still fails to factually establish the use of Chlorine as a fining agent. The declaration makes broad statements as to Bromine being a better fining agent than Chlorine, where none of these statements are supported. The declaration speaks of prior work done at Corning on similar glass showing the use of both chlorine and bromine as fining agents. The inclusion of such tests in the declaration would concretely show the relationship between bromine and chlorine as fining agents without comparing them in general unsupported terms. Statements supported by said data would therefore be able to relate the prior art to the alleged unexpected results. If the statements submitted in the declaration were properly supported by the above mentioned data, the declaration would successfully show unexpected results

> based solely on the ratio of alkaline earth oxides to aluminum oxide and the magnesium oxide amount added thereto. At the current juncture, it is still unclear whether the 'unexpected results' are attributable to the difference in halide gases used and not to the ratio/MgO amount used, as it is stated that the use of Cl as a fining agent eliminates the fine bubbles (blisters) in the melt. (emphasis in original)

3. In particular, I make this declaration to provide the Examiner with data developed by Corning which shows that bromine is a better fining agent than chlorine for LCD glasses. This data is from the early 1990's, which is before I joined Corning. Accordingly, my knowledge of the work done by Corning in this period and the resulting data is based on discussions I have had over the years with Corning scientists who were involved with LCD glasses in the 1990's, as well as on reports maintained by Corning regarding its work on LCD glasses.

4. The data from the 1990's which compared bromine and chlorine fining of LCD glasses was developed in connection with Corning's efforts to find a replacement for arsenic as a fining agent for Corning's Code 1737 LCD glass, which was being sold at the time. Corning's Code 1737 LCD glass is the subject of Dumbaugh et al., U.S. Patent No. 5,374,595, which I understand was relied on by the Examiner in the April 1, 2008 Office Action for this application. It is also the comparative example of Chacon et al., U.S. Patent No. 6,831,029, relied on by the Examiner in the October 13, 2009 Office Action.

5. The comparison study was performed under the direction of Mr. James C. Hayes, who retired from Corning in 1999. The data was developed as part of a multi-part study which also included fluorine fining and combinations of halide fining and tin fining. Attached hereto as Exhibit A is a copy of a table and chart which Mr. Hayes included in a 1993 summary report for the project. As described in the report, the experiments involved preparing crucible melts and counting the number of seeds (small bubbles) in slices (Sl 1 through Sl 5) at increasing distances from the top of the melt. In computing averages, the top slice (Sl 1) was omitted since it contained bubbles captured by a scum which formed on the top of the molten glass surface. The strikeouts in the

table and chart of Exhibit A change SnO_2 to SnO so as to indicate that in the experiments that used tin oxide, the raw material was tin II oxide as opposed to tin IV oxide, i.e., SnO as opposed to SnO_2. Because Corning used nitrates as batch components at this time, the redox ratio for the tin in the glass would have been similar to that associated with SnO_2 as the raw material. The notation "vacuum fining project" in the top line of the table refers to subsequent work which included halide fining in combination with vacuum fining, and the designation "191PNY glass" indicates that the glass used in the tests was a laboratory version of a high strain point 1737-type glass. The seed counts are reported in seeds/cubic inch.

6. As shown in the table and chart of Exhibit A, bromine and chlorine were each tested at the 0.5 wt.% level both by themselves and in combination with tin oxide. Chlorine was also tested at the 1.0 wt.% level. Arsenic at 0.8 wt.% was used as a standard for the experiments. The following table summarizes the bromine and chlorine data of Exhibit A. In particular, it summarizes the average number of seeds in seeds/cubic inch found in the crucible melts.

0.5%Br	0.5%Br+SnO	0.5%Cl	1.0%Cl	0.5%Cl+SnO
8670	203	21,400	91,700	26,500

7. In paragraph 5 of my July 24, 2009 declaration, I stated that when in the course of my research, I performed the RO/Al_2O_3 experiments of that declaration "I chose bromine because prior work at Corning had shown that bromine is a more effective fining agent for LCD glasses than chlorine." At the time I made this choice of bromine, I was aware of the above work on halide fining which had been done at Corning in the 1990's. As the above experimental data from that era shows, bromine is clearly superior to chlorine as a fining agent for LCD glasses. Accordingly, the tin+bromine fining of the experiments described in my July 24, 2009 declaration was a more stringent test of my RO/Al_2O_3 -- MgO combination than tin+chlorine fining would have been.

8. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

1/8/2010
(Date)

Adam J. Ellison

HALIDE SEARCH 191PNY GLASS				Jul-93			VACUUM FINING PROJECT					
	0.8%As#1	0.8%As#2	0.5%F	F+SnO2	0.5%Cl	Cl+SnO2	0.5%Br	Br+SnO2	F+Br	F+Cl	Cl+Br	1%Cl
Sl 1	17300	31900	34600	36400	61500	60800	32700	23300	28700	36000	46600	114200
Sl 2	108	189	11300	39600	38500	36300	30200	863	634	6270	27400	99300
Sl 3	0	0	1560	46500	21200	28800	6670	40	10	795	11500	89900
Sl 4	0	0	123	43300	5040	23300	1830	3.8	8.4	96	532	75300
Sl 5						17600	108	0		16		101900
Avg Size " Cordy	0.004	0.004	0.007	0.004	0.004	0.003	0.005 very	0.003 very	0.006	0.008	0.006	<.001
	0.8%As#1	0.8%As#2	0.5%F	F+SnO2	0.5%Cl	Cl+SnO2	0.5%Br	Br+SnO2	F+Br	F+Cl	Cl+Br	1%Cl
Ucl 95%	101	232	11510	141264	69978	86655	28351	864	540	5297	36951	299859
Lcl 95%	9	22	1076	13211	6544	8104	2651	62	50	495	3456	28043
avg	31	71	3520	43200	21400	26500	8670	203	165	1620	11300	91700

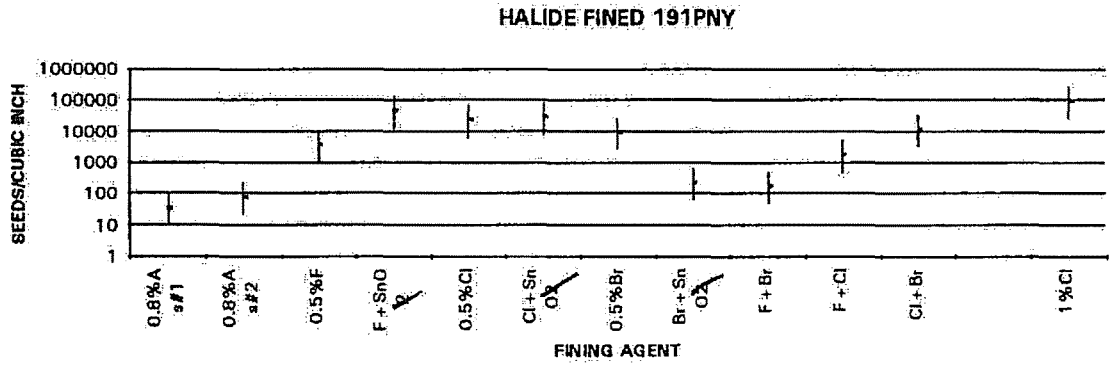


Exhibit A

Electronic Acknowledgement Receipt

EFS ID:	6801781
Application Number:	11478493
International Application Number:	
Confirmation Number:	5778
Title of Invention:	Fining of boroalumino silicate glasses
First Named Inventor/Applicant Name:	Adam J.G. Ellison
Customer Number:	22928
Filer:	Maurice M. Klee/Anya Klee
Filer Authorized By:	Maurice M. Klee
Attorney Docket Number:	ADP-231 (SP05-073)
Receipt Date:	13-JAN-2010
Filing Date:	28-JUN-2006
Time Stamp:	14:17:37
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	adp231_US_a_Response.pdf	276407 948d093e7081301a47e5af5f37fc27ed3496b2c8	no	7

Warnings:	
Information:	

2	Rule 130, 131 or 132 Affidavits	adp231_US_a_Supp_Declaration.pdf	464858 f5bc37e0b3471f11b80356f0cc9fc37d1c1232e5	no	5

Warnings:	
Information:	
Total Files Size (in bytes):	741265

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)	5778

22928 7590 04/15/2010

CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

EXAMINER	
HOBAN, MATTHEW E	
ART UNIT	PAPER NUMBER
1793	

NOTIFICATION DATE	DELIVERY MODE
04/15/2010	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usdocket@corning.com

Office Action Summary	Application No.	Applicant(s)	
	11/478,493	ELLISON, ADAM J.G.	
	Examiner	Art Unit	
	Matthew E. Hoban	1793	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *13 January 2010*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,2 and 4-20* is/are pending in the application.

4a) Of the above claim(s) *18-20* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-2 and 4-17* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

1. Claims 1-2, 4-5, and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa in 6169047.

Regarding Claim 1: Nishizawa teaches in Example 29 a glass composition having in mol%, 67% SiO_2. 12% Al_2O_3, 7% B_2O_3, 3% MgO, 9% CaO, 2% SrO. This composition has an MO/Al_2O_3 value of 1.167.

When teaching this composition, Nishizawa is silent as to the fining agents used in creating it.

However, in Column 4, lines, 30-35, Nishizawa specifically states that a total amount of at most 5 mol% of SnO_2 can be used as a fining agent. It would have been obvious to use tin oxide as a fining agent as Nishizawa expressly states use of these compounds. One would be motivated to use tin oxide, as it increases the clarity of the glass, which is

stated by Nishizawa (See Column 4, Lines 30-35). The amount of fining agent taught by Nishizawa represents an overlapping range with that of the instant claim. It would have been obvious for one of ordinary skill in the art to select from this overlapping range and arrive at the instantly claimed invention. See MPEP 2144.04.

Regarding Claim 2, 4-5: Nishizawa does not include these components and specifically states that they should not be included as they are toxic (See Column 4, Lines 35-40)

Regarding Claim 8: The glass of Nishizawa has a strain point of 680 degrees (See Table 4).

Double Patenting

2. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

3. Claims 1-2 and 4-17 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-7 and 11-12 of U.S. Patent No. 7534734. Although the conflicting claims are not identical, they are not patentably distinct from each other because the claims are to the exact same range of compositions having a ratio between RO and Al_2O_3 greater than 1, and also having the same properties as those seen in claims 7-8 and 11-12.

Response to Arguments

4. Applicant's arguments, see the Declarations filed 1/13/2010 7/24/2009, 3/30/2009 and 4/28/2009 collectively, with respect to claims 1- have been fully considered and are persuasive. The art rejection over Chacon in view of Narita of claims 1-17 has been withdrawn.

5. Applicant's arguments filed 1/13/2010 concerning the Obvious Double Patenting rejection have been fully considered but they are not persuasive. The relationship with the patented claims is not one of domination, as one set of claims does not fully encompass the other. Specifically, see the Strontium and Barium concentrations in either independent claim, and the additives used in fining. Furthermore The instant claims and those of 7534734 are truly overlapping and thus obviate one another. Thereafter, the ODP rejection is maintained. Applicants arguments that it would not

have been obvious for one of ordinary skill in the art to chose from the limited list of fining agents presented by Nishizawa is not persuasive. Nishizawa gives clear direction in showing a suitable group of fining agents among which that which is claimed, Tin Oxide, is included. Nishizawa also specifically teaches a composition having the required ratio between RO/Al2O3. It would thereafter not be unobvious to select Tin Oxide out of the handful of suitable fining agents presented by Nishizawa. Finally, as far as the mol% used. Nishizawa teaches an amount less than 5mol%. The claims are to greater than .01 mol%. Selecting an amount in this overlapping range does not seem unobvious. Furthermore, applicant's conversion of wt% to mol% is unconvincing. Nishizawa teaches compositions and provides both wt and mol%, based on the examples, it would seem reasonable to believe that the experiments were based on MOL% and converted to wt%. This contention is based on the following series of examples 39-43, where the molar % of SiO_2 B_2O_3 and Al_2O_3 are held constant while the RO mol% is varied. For the sake of argument, even in the situation where Nishizawa converted the figures incorrectly, he still teaches the usefulness of such a glass. The use of such a glass is explicitly taught by Nishizawa, Thereafter the ratio between RO and aluminum is explicitly taught, where it would be obvious to increase the fineness with Tin and other clarifiers.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew E. Hoban whose telephone number is (571)

270-3585. The examiner can normally be reached on Monday - Friday from 7:30 AM to 5 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jerry Lorengo can be reached on (571) 272-1233. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/J.A. LORENGO/
Supervisory Patent Examiner, Art Unit 1793

/Matthew E Hoban/
Examiner, Art Unit 1793

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11478493	ELLISON, ADAM J.G.
	Examiner	Art Unit
	Matthew E Hoban	1793

SEARCHED

Class	Subclass	Date	Examiner
501	+text	3/20/2008	meh
501	66	10/07/09	mh

SEARCH NOTES

Search Notes	Date	Examiner
See East Search History	3/20/2008	meh
Inventor Search Completed through PALM	3/20/2008	meh
See EAST search history	11/24/2008	mh
Consulted with Jerry Lorengo regarding Declaration	10/07/09	mh
Consulted with Lizz Bolden regarding Declaration	10/07/09	mh
Updated East Search	10/07/09	mh
Updated East Search History	4/12/10	mh

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S35	18	"733189"	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 10:10
S36	4	"7133189"	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 10:10
S37	28	("2231811" | "2961328" | "3338696" | "3682609" | "4394453" | "4824808" | "5116788" | "5244847" | "5374595" | "5506180" | "5508237" | "5770535" | "5801109" | "5811361" | "5851939" | "5885914" | "6060168" | "6096670" | "6169047" | "6250111" | "6319867" | "6468933").PN. OR ("6831029").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:23
S38	28	("2231811" | "2961328" | "3338696" | "3682609" | "4394453" | "4824808" | "5116788" | "5244847" | "5374595" | "5506180" | "5508237" | "5770535" | "5801109" | "5811361" | "5851939" | "5885914" | "6060168" | "6096670" | "6169047" | "6250111" | "6319867" | "6468933").PN. OR ("6831029").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47
S39	0	S38 not S37	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47

S40	27	("2231811" | "2961328" | "3338696" | "3682609" | "4394453" | "4824808" | "5116788" | "5244847" | "5374595" | "5506180" | "5508237" | "5770535" | "5801109" | "5811361" | "5851939" | "5885914" | "6060168" | "6096670" | "6169047" | "6250111" | "6319867" | "6468933" | "6831029").PN. OR ("7365038").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47
S41	1	S40 not S38	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47
S42	762160	toxic (tin "SnO.sub.2")	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:51
S43	45	toxic same (tin "SnO. sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:51
S44	122	free same ("Sb.sub.2O. sub.3" or "Sb.sub.2 O. sub.3" antimony) same (Arsenic "As.sub.2O. sub.3" "As.sub.2 O. sub.3") and (tin "SnO. sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:06
S45	6	free same toxic same ("Sb.sub.2O.sub.3" or "Sb.sub.2 O.sub.3" antimony) same (Arsenic "As.sub.2O. sub.3" "As.sub.2 O. sub.3") and (tin "SnO. sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:07
S46	27	toxic same ("Sb. sub.2O.sub.3" or "Sb. sub.2 O.sub.3" antimony) same (Arsenic "As.sub.2O. sub.3" "As.sub.2 O. sub.3") and (tin "SnO. sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:09

S47	2	"20020042337"	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:42
S48	9	(US-20040209758-$).did. or (US-6468933-$ or US-5801109-$ or US-5885914-$ or US-7365038-$ or US-6831029-$ or US-6169047-$ or US-6306786-$ or US-6846760-$).did.	US-PGPUB; USPAT	OR	ON	2008/11/21 10:05
S49	3	S48 and toxic	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/21 10:05

4/12/2010 8:42:17 AM
C:\Documents and Settings\mhoban\My Documents\EAST\Workspaces\11478493.wsp

[320] Attorney Docket No. : ADP-231 US PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Serial No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A PRIOR PATENT

The owner, Corning Incorporated, of the entire interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application, which would extend beyond the expiration date of the full statutory term defined in 35 U.S.C. 154 to 156 and 173, as presently shortened by any terminal disclaimer, of prior Patent No. 7,534,734. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term as defined in 35 U.S.C. 154 to 156 and 173 of the prior patent, as presently shortened by any terminal disclaimer, in the event that it later: expires for

failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims cancelled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

The undersigned is an attorney of record.

Respectfully submitted,

Date: 7/2/11

Thomas R. Beall
Reg. No. 40,424
Corning Incorporated
SP-TI-03-1
Corning, New York 14831
(607) 974-3921

PTO/SB/17 (10-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number

Effective on 12/08/2004.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2009

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 140.00

Complete if Known	
Application Number	11478493
Filing Date	June 28, 2006
First Named Inventor	Ellison
Examiner Name	M. Hoban
Art Unit	1793
Attorney Docket No.	ADP-231 US

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☑ Deposit Account Deposit Account Number: 111158 Deposit Account Name: Maurice M. Klee

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
		Small Entity		Small Entity		Small Entity	
Application Type	**Fee ($)**	**Fee ($)**	**Fee ($)**	**Fee ($)**	**Fee ($)**	**Fee ($)**	**Fees Paid ($)**
Utility	330	165	540	270	220	110	
Design	220	110	100	50	140	70	
Plant	220	110	330	165	170	85	
Reissue	330	165	540	270	650	325	
Provisional	220	110	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	**Fee ($)**	**Small Entity Fee ($)**
Each claim over 20 (including Reissues)	52	26
Each independent claim over 3 (including Reissues)	220	110
Multiple dependent claims	390	195

Total Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
_____	- 20 or HP =	_____	x _____	=	_____

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
_____	- 3 or HP =	_____	x _____	=	_____

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	
Fee ($)	**Fee Paid ($)**
_____	_____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		**Extra Sheets**		**Number of each additional 50 or fraction thereof**	**Fee ($)**		**Fee Paid ($)**
_____	- 100 =	_____	/ 50 =	_____ (round **up** to a whole number)	x _____	=	_____

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge): Fee under 37 CFR 1.20(d) for submission of a Statutory Disclaimer	140.00

SUBMITTED BY

Signature	/Maurice M. Klee/	Registration No. (Attorney/Agent) 30399	Telephone (203) 255-1400
Name (Print/Type)	Maurice M. Klee		Date July 15, 2010

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

[321] Attorney Docket No. : ADP-231 US PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Serial No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

In accordance with 37 CFR §1.56, 37 CFR §1.97(d), and 37 CFR §1.97(e)(1), applicant wishes to call the Examiner's attention to the reference listed on the Information Disclosure Statement by Applicant (PTO Form SB08a) submitted herewith. No copy of the reference, which is a U.S. patent document, is submitted herewith pursuant to 37 CFR §1.98(a)(2)(ii).

The undersigned certifies that this reference was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement. In particular, U.S. Patent No. 6,992,030 is an English language equivalent of TW 12253441, which was cited in an April 22, 2010 Taiwanese Office Action regarding applicant's corresponding Taiwanese patent application.

Submitted herewith is the fee specified in 37 CFR §1.17(p) for this submission.

The Examiner is respectfully requested to initial a copy of PTO Form SB08a submitted herewith and return it to applicant to indicate consideration of the reference listed thereon in connection with the prosecution of this application.

Respectfully submitted,

Date: July 15, 2010

/Maurice M. Klee/
Maurice M. Klee, Ph.D.
Reg. No. 30,399
Attorney for Applicant
1951 Burr Street
Fairfield, CT 06824
(203) 255-1400

[321] Attorney Docket No. : ADP-231 US

MAIL STOP AF- PATENT
Response Under
37 CFR §1.116
Expedited Procedure
Examining Group 1793

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

AMENDMENT AFTER FINAL REJECTION

This Amendment After Final Rejection is submitted in response to the Office Action dated April 15, 2010. Its contents are:

(1) a listing of the claims of the application which includes the amendments to the claims being made by this Amendment -- page 2; and

(2) applicant's Remarks -- page 6.

No extension of time is believed to be necessary for the filing of this Amendment, but if an extension of time is required, applicant requests that this be considered a petition therefor. The Director is hereby authorized to charge any fees which may be required for such an extension to Deposit Account No. 11-1158.

Amendments to the Claims:

This listing of claims will replace all prior versions of the claims in this application:

Listing of Claims:

Claim 1 (currently amended): An alkali-free glass comprising in mole percent on an oxide basis:

SiO_2:	64.0-71.0
Al_2O_3:	9.0-12.0
B_2O_3:	7.0-12.0
MgO:	1.0-3.0
CaO:	6.0-11.5
SrO:	0-2.0
BaO:	0-0.1

wherein:

(a) $1.00 \leq \Sigma[RO]/[Al_2O_3] \leq 1.25$,

where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO; [[and]]

(b) the glass has the compositional characteristic that on an oxide basis, the glass comprises at least 0.01 mole percent SnO_2; and

(c) the glass has a density that is less than or equal to 2.41 grams/cm^3.

Claim 2 (previously presented): The glass of Claim 1 wherein the glass has the additional compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent Sb_2O_3.

Claim 3 (canceled)

Claim 4 (previously presented): The glass of Claim 1 wherein the glass has the further compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3.

Claim 5 (previously presented): The glass of Claim 2 wherein the glass has the further compositional characteristic that on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3.

Claim 6 (currently amended) An alkali-free glass comprising in mole percent on an oxide basis:

SiO_2:	64.0-71.0
Al_2O_3:	9.0-12.0
B_2O_3:	7.0-12.0
MgO:	1.0-3.0
CaO:	6.0-11.5
BaO:	0-0.1

wherein the glass has the compositional characteristics:

(a) ~~The glass of Claim 1 wherein~~ on an oxide basis, SrO is at most 1.0 mole percent;

(b) on an oxide basis, the glass comprises at least 0.01 mole percent SnO_2; and

(c) $1.00 \leq \Sigma[RO]/[Al_2O_3] \leq 1.25$, where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO.

Claim 7 (currently amended) The glass of Claim [[1]] 6 wherein the glass has a density that is less than or equal to 2.41 grams/cm^3.

Claim 8 (original) The glass of Claim 1 wherein the glass has one or more of the following properties:

(a) a liquidus viscosity that is greater than or equal to 100,000 poise;

(b) a strain point that is greater than or equal to 650°C;

(c) a linear coefficient of thermal expansion (CTE) over the temperature range 0-300 °C which satisfies the relationship:

$$28 \times 10^{-7}/°C \leq CTE \leq 34 \times 10^{-7}/°C.$$

Claim 9 (original) An alkali-free glass comprising in mole percent on an oxide basis:

SiO_2:	64.0-71.0
Al_2O_3:	9.0-12.0
B_2O_3:	7.0-12.0
MgO:	1.0-3.0
CaO:	6.0-11.5
SrO:	0-1.0
BaO:	0-0.1

wherein:

$$\Sigma[RO]/[Al_2O_3] \geq 1.00,$$

where $[Al_2O_3]$ is the mole percent of Al_2O_3 and $\Sigma[RO]$ equals the sum of the mole percents of MgO, CaO, SrO, and BaO.

Claim 10 (original) The glass of Claim 9 wherein:

$$\Sigma[RO]/[Al_2O_3] \leq 1.25.$$

Claim 11 (original) The glass of Claim 9 wherein the glass has a density that is less than or equal to 2.41 grams/cm^3.

Claim 12 (original) The glass of Claim 9 wherein the glass has one or more of the following properties:

(a) a liquidus viscosity that is greater than or equal to 100,000 poise;

(b) a strain point that is greater than or equal to 650°C;

(c) a linear coefficient of thermal expansion (CTE) over the temperature range 0-300 °C which satisfies the relationship:

$$28 \times 10^{-7}/°C \leq CTE \leq 34 \times 10^{-7}/°C.$$

Claim 13 (original) The glass of Claim 9 wherein the glass has at least one of the following compositional characteristics:

(a) on an oxide basis, the glass comprises at most 0.05 mole percent As_2O_3;

(b) on an oxide basis, the glass comprises at most 0.05 mole percent Sb_2O_3;

(c) on an oxide basis, the glass comprises at least 0.01 mole percent SnO_2.

Claim 14 (original) The glass of Claim 13 wherein the glass has compositional characteristics (a) and (b).

Claim 15 (original) The glass of Claim 13 wherein the glass has compositional characteristics (a) and (c).

Claim 16 (original) The glass of Claim 13 wherein the glass has compositional characteristics (b) and (c).

Claim 17 (original) The glass of Claim 13 wherein the glass has compositional characteristics (a), (b), and (c).

Claims 18-20 (canceled)

REMARKS

This Amendment After Final Rejection is submitted in response to the Office Action dated April 15, 2010.

The claim amendments set forth above are being made to put this application into condition for allowance. In particular, in the April 15th Office Action, dependent Claims 6 and 7, as well as independent Claim 9 and its dependent Claims 10-17, were not rejected under §103. By the above amendment, dependent Claim 6 has been written in independent form and the limitation of Claim 7 has been incorporated in Claim 1. Accordingly, the entry of this Amendment will remove the §103 rejection.

The April 15th Office Action also included an obviousness-type double patenting rejection based on commonly-assigned U.S. Patent No. 7,534,734. Submitted herewith is a terminal disclaimer directed to the '734 patent.

This terminal disclaimer is being made without prejudice and its sole purpose is to obviate the double patent rejection made by the Examiner. See MPEP §804.02. Pursuant to the holding in, for example, Quad Environmental Technologies Corp. v. Union Sanitary District, 946 F.2d 870, 20 USPQ2d 1392 (Fed. Cir. 1991), this terminal disclaimer is not to be construed in any way as an obviousness admission with regard to any of the claims of this application or to indicate acquiescence in, or agreement with, the arguments and assertions made in connection with the rejection.

More generally, the above amendments are being made without prejudice to applicant's right to pursue broader claims in one or more continuation or divisional

applications. Also, the making of these amendments should not be taken as an acquiescence in, or an agreement with, any of the arguments, assertions, or rejections made in the Office Action.

In view of the above, applicant believes that this application is now in condition for allowance. Accordingly, reconsideration, entry of this Amendment, and the timely issuance of a Notice of Allowance are respectfully requested.

Respectfully submitted,

Date: July 15, 2010

/Maurice M. Klee/

Maurice M. Klee, Ph.D.
Reg. No. 30,399
Attorney for Applicant
1951 Burr Street
Fairfield, CT 06824
(203) 255-1400

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet | | of |

Complete if Known	
Application Number	11478493
Filing Date	June 28, 2006
First Named Inventor	Ellison
Art Unit	1793
Examiner Name	M. Hoban
Attorney Docket Number	ADP-231 US

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	US- 6992030 B2	01-31-2006	Paulson	
		US-			
		US-			
		US-			
		US-			
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		US-			
		US-			
		US-			

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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PTO/SB/17 (10-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number

Effective on 12/08/2004.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2009

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 180.00

Complete if Known	
Application Number	11478493
Filing Date	June 28, 2006
First Named Inventor	Ellison
Examiner Name	M. Hoban
Art Unit	1793
Attorney Docket No.	ADP-231 US

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☑ Deposit Account Deposit Account Number: 111158 Deposit Account Name: Maurice M. Klee

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
		Small Entity		Small Entity		Small Entity	
Application Type	**Fee ($)**	**Fee ($)**	**Fee ($)**	**Fee ($)**	**Fee ($)**	**Fee ($)**	**Fees Paid ($)**
Utility	330	165	540	270	220	110	
Design	220	110	100	50	140	70	
Plant	220	110	330	165	170	85	
Reissue	330	165	540	270	650	325	
Provisional	220	110	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	**Fee ($)**	**Small Entity Fee ($)**
Each claim over 20 (including Reissues)	52	26
Each independent claim over 3 (including Reissues)	220	110
Multiple dependent claims	390	195

Total Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
_____	- 20 or HP =	_____	x _____	=	_____

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
_____	- 3 or HP =	_____	x _____	=	_____

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	
Fee ($)	**Fee Paid ($)**
_____	_____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		**Extra Sheets**		**Number of each additional 50 or fraction thereof**	**Fee ($)**		**Fee Paid ($)**
_____	- 100 =	_____	/ 50 =	_____ (round **up** to a whole number)	x _____	=	_____

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge): Fee under 37 CFR 1.17(p) for submission of an IDS	180.00

SUBMITTED BY

Signature	/Maurice M. Klee/	Registration No. (Attorney/Agent) 30399	Telephone (203) 255-1400
Name (Print/Type)	Maurice M. Klee		Date July 15, 2010

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Patent Application Fee Transmittal

Application Number:	11478493
Filing Date:	28-Jun-2006
Title of Invention:	Fining of boroalumino silicate glasses
First Named Inventor/Applicant Name:	Adam J.G. Ellison
Filer:	Maurice M. Klee/Anya Klee
Attorney Docket Number:	ADP-231 (SP05-073)

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
Statutory disclaimer	1814	1	140	140
		Total in USD ($)		**320**

Electronic Acknowledgement Receipt

EFS ID:	8025277
Application Number:	11478493
International Application Number:	
Confirmation Number:	5778
Title of Invention:	Fining of boroalumino silicate glasses
First Named Inventor/Applicant Name:	Adam J.G. Ellison
Customer Number:	22928
Filer:	Maurice M. Klee/Anya Klee
Filer Authorized By:	Maurice M. Klee
Attorney Docket Number:	ADP-231 (SP05-073)
Receipt Date:	15-JUL-2010
Filing Date:	28-JUN-2006
Time Stamp:	16:07:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$320
RAM confirmation Number	2613
Deposit Account	111158
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment After Final	adp231_US_a_Amendment.PDF	239743 8bc3a3b12a3babc6b619b852e63f1f3e31c2f3da	no	7
Warnings:					
Information:					
2	Terminal Disclaimer Filed	adp231_US_a_Terminal_Disclaimer_SIGNED.pdf	508868 c3ec9b1a4676c82c2d50270f2624fdc4d3b65ee2	no	2
Warnings:					
Information:					
3	Miscellaneous Incoming Letter	adp231_US_a_Fee_Transmittal_sb0017-TD.pdf	443904 ca54232da7cef51f48204dbd62e1d0eb40b289bc	no	1
Warnings:					
Information:					
4	Transmittal Letter	adp231_US_a_IDS_Letter.PDF	63542 f4571a3cbff429ca33ef2875cc7b3cd7e131883c	no	1
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Filed (SB/08)	adp231_US_a_IDS_sb0008a.pdf	397219 6c69509b91103d621ce000829a5ccc8019849810	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
6	Miscellaneous Incoming Letter	adp231_US_a_Fee_Transmittal_sb0017-IDS.pdf	443107 d373644c1e8901edf41aad28aaa7edb2ac8dbc72	no	1
Warnings:					
Information:					
7	Fee Worksheet (PTO-875)	fee-info.pdf	31323 969e14089004c513a6c2c92162a4f2645dcaf97f	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2127706		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/478,493	06/28/2006	

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY ☐		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	07/15/2010	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 16	Minus	** 20	= 0	X $ =		OR	X $52=	0
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $ =		OR	X $220=	0
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/PAMELA THERATT/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
	11/478,493	ELLISON, ADAM J.G.	

Document Code - DISQ	Internal Document – DO NOT MAIL

TERMINAL DISCLAIMER	☒ APPROVED	☐ DISAPPROVED
Date Filed : 7/15/10	This patent is subject to a Terminal Disclaimer	

Approved/Disapproved by:
j.proctor

U.S. Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

22928 7590 08/10/2010

CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

EXAMINER	
HOBAN, MATTHEW E	
ART UNIT	PAPER NUMBER
1793	

DATE MAILED: 08/10/2010

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)	5778

TITLE OF INVENTION: FINING OF BOROALUMINO SILICATE GLASSES

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1510	$300	$0	$1810	11/10/2010

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (Rev. 08/07) Approved for use through 08/31/2010.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

22928 7590 08/10/2010

CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)	5778

TITLE OF INVENTION: FINING OF BOROALUMINO SILICATE GLASSES

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1510	$300	$0	$1810	11/10/2010

EXAMINER	ART UNIT	CLASS-SUBCLASS
HOBAN, MATTHEW E	1793	501-066000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:

❑ Issue Fee

❑ Publication Fee (No small entity discount permitted)

❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**

❑ A check is enclosed.

❑ Payment by credit card. Form PTO-2038 is attached.

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

❑ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)	5778

22928 7590 08/10/2010

CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

EXAMINER	
HOBAN, MATTHEW E	
ART UNIT	PAPER NUMBER
1793	

DATE MAILED: 08/10/2010

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)

(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 101 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 101 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

PTOL-85 (Rev. 08/07) Approved for use through 08/31/2010.

Notice of Allowability	Application No.	Applicant(s)	
	11/478,493	ELLISON, ADAM J.G.	
	Examiner	Art Unit	
	Matthew E. Hoban	1793	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *the Terminal Disclaimer and Amendments filed 7/15/2010*.

2. ☒ The allowed claim(s) is/are *1,2 and 4-17*.

3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 7/15/2010
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

/Matthew E Hoban/
Examiner, Art Unit 1793

REASONS FOR ALLOWANCE

1. The following is an examiner's statement of reasons for allowance: The claimed glass composition cannot be anticipated or obviated by the prior art of reference. Specifically the claimed glass with the given composition requirement that RO/Al_2O_3 is greater than unity combined with the narrow and precise representation of the given composition lead to the patentability of the claims. Applicant has shown through evidence that the ratio between the alkali earth and aluminum components causes dramatic changes in the glass, which would be unexpected in the art.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew E. Hoban whose telephone number is (571) 270-3585. The examiner can normally be reached on Monday - Friday from 7:30 AM to 5 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jerry Lorengo can be reached on (571) 272-1233. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/C. Melissa Koslow/
Primary Examiner, Art Unit 1793

/Matthew E Hoban/
Examiner, Art Unit 1793

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11478493	ELLISON, ADAM J.G.
	Examiner	Art Unit
	Matthew E Hoban	1793

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	03/20/2008	07/30/2010							
	1	✓	=							
	2	✓	=							
	3	✓	-							
	4	✓	=							
	5	✓	=							
	6	✓	=							
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	13	✓	=							
	14	✓	=							
	15	✓	=							
	16	✓	=							
	17	✓	=							
	18	÷	-							
	19	÷	-							
	20	÷	-							

OK TO ENTER: /M.H./ OK TO ENTER: /M.H./

[321] Attorney Docket No. : ADP-231 US

MAIL STOP AF- PATENT
Response Under
37 CFR §1.116
Expedited Procedure
Examining Group 1793

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

AMENDMENT AFTER FINAL REJECTION

This Amendment After Final Rejection is submitted in response to the Office Action dated April 15, 2010. Its contents are:

(1) a listing of the claims of the application which includes the amendments to the claims being made by this Amendment -- page 2; and

(2) applicant's Remarks -- page 6.

No extension of time is believed to be necessary for the filing of this Amendment, but if an extension of time is required, applicant requests that this be considered a petition therefor. The Director is hereby authorized to charge any fees which may be required for such an extension to Deposit Account No. 11-1158.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 5778

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/478,493	06/28/2006	252	1793	ADP-231 (SP05-073)

APPLICANTS
Adam J.G. Ellison, Painted Post, NY;

**** CONTINUING DATA ***************************
This appln claims benefit of 60/694,478 06/28/2005

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
07/27/2006

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /MATTHEW E HOBAN/ Examiner's Signature	☐ Met after Allowance /mh/ Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		NY	3	20	3

ADDRESS
CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

TITLE
Fining of boroalumino silicate glasses

FILING FEE RECEIVED		
1000	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet | | of | |

Complete if Known	
Application Number	11478493
Filing Date	June 28, 2006
First Named Inventor	Ellison
Art Unit	1793
Examiner Name	M. Hoban
Attorney Docket Number	ADP-231 US

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/M.H./	1	US- 6992030 B2	01-31-2006	Paulson	
		US-			
		US-			
		US-			
		US-			
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		US-			
		US-			

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]

Examiner Signature	/Matthew Hoban/	Date Considered	07/30/2010

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2050	501/55,65,66.ccls.	US-PGPUB; USPAT; USOCR	OR	ON	2010/07/30 14:22
L2	1939	501/55,65,66.ccls. and @py<"2009"	US-PGPUB; USPAT; USOCR	OR	ON	2010/07/30 14:23
L3	1056	501/55,65,66.ccls. and (Ba Barium BaO baria)	US-PGPUB; USPAT; USOCR	OR	ON	2010/07/30 14:27
L4	1042	501/55,65,66.ccls. and (Ca Calcium CaO Calcia) and (MgO Magnesium MgO Magnesia)	US-PGPUB; USPAT; USOCR	OR	ON	2010/07/30 14:27
L5	13	"6692030"	US-PGPUB; USPAT; USOCR	OR	ON	2010/07/30 15:00
L6	1	"6992030"	US-PGPUB; USPAT; USOCR	OR	ON	2010/07/30 15:00
S35	18	"733189"	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 10:10
S36	4	"7133189"	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 10:10
S37	28	("2231811" | "2961328" | "3338696" | "3682609" | "4394453" | "4824808" | "5116788" | "5244847" | "5374595" | "5506180" | "5508237" | "5770535" | "5801109" | "5811361" | "5851939" | "5885914" | "6060168" | "6096670" | "6169047" | "6250111" | "6319867" | "6468933").PN. OR ("6831029").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:23

S38	28	("2231811" | "2961328" | "3338696" | "3682609" | "4394453" | "4824808" | "5116788" | "5244847" | "5374595" | "5506180" | "5508237" | "5770535" | "5801109" | "5811361" | "5851939" | "5885914" | "6060168" | "6096670" | "6169047" | "6250111" | "6319867" | "6468933").PN. OR ("6831029").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47
S39	0	S38 not S37	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47
S40	27	("2231811" | "2961328" | "3338696" | "3682609" | "4394453" | "4824808" | "5116788" | "5244847" | "5374595" | "5506180" | "5508237" | "5770535" | "5801109" | "5811361" | "5851939" | "5885914" | "6060168" | "6096670" | "6169047" | "6250111" | "6319867" | "6468933" | "6831029").PN. OR ("7365038").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47
S41	1	S40 not S38	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:47
S42	762160	toxic (tin "SnO.sub.2")	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:51
S43	45	toxic same (tin "SnO. sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 12:51

S44	122	free same ("Sb.sub.2O.sub.3" or "Sb.sub.2 O.sub.3" antimony) same (Arsenic "As.sub.2O.sub.3" "As.sub.2 O.sub.3") and (tin "SnO.sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:06
S45	6	free same toxic same ("Sb.sub.2O.sub.3" or "Sb.sub.2 O.sub.3" antimony) same (Arsenic "As.sub.2O.sub.3" "As.sub.2 O.sub.3") and (tin "SnO.sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:07
S46	27	toxic same ("Sb.sub.2O.sub.3" or "Sb.sub.2 O.sub.3" antimony) same (Arsenic "As.sub.2O.sub.3" "As.sub.2 O.sub.3") and (tin "SnO.sub.2") and "501".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:09
S47	2	"20020042337"	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/17 13:42
S48	9	(US-20040209758-$).did. or (US-6468933-$ or US-5801109-$ or US-5885914-$ or US-7365038-$ or US-6831029-$ or US-6169047-$ or US-6306786-$ or US-6846760-$).did.	US-PGPUB; USPAT	OR	ON	2008/11/21 10:05
S49	3	S48 and toxic	US-PGPUB; USPAT; USOCR	OR	ON	2008/11/21 10:05

7/30/2010 3:22:51 PM
C:\Documents and Settings\mhoban\My Documents\EAST\Workspaces\11478493.wsp

Issue Classification

Application/Control No.	Applicant(s)/Patent Under Reexamination
11478493	ELLISON, ADAM J.G.
Examiner	**Art Unit**
Matthew E Hoban	1793

ORIGINAL		INTERNATIONAL CLASSIFICATION	
CLASS	SUBCLASS	CLAIMED	NON-CLAIMED
501	66	C 0 3 C 3 / 076 (2006.0)	
CROSS REFERENCE(S)		C 0 3 C 3 / 089 (2006.0)	
		C 0 3 C 3 / 091 (2006.0)	

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
501	55	65			

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☒ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

/Matthew E Hoban/ Examiner.Art Unit 1793 (Assistant Examiner)	7/30/10 (Date)	**Total Claims Allowed:** 16
/C. Melissa Koslow/ Primary Examiner.Art Unit 1793 (Primary Examiner)	08/02/2010 (Date)	O.G. Print Claim(s) 1 O.G. Print Figure ----------

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11478493	ELLISON, ADAM J.G.
	Examiner	**Art Unit**
	Matthew E Hoban	1793

SEARCHED

Class	Subclass	Date	Examiner
501	+text	3/20/2008	meh
501	66	10/07/09	mh
501	55, 65, 66	7/30/10	mh

SEARCH NOTES

Search Notes	Date	Examiner
See East Search History	3/20/2008	meh
Inventor Search Completed through PALM	3/20/2008	meh
See EAST search history	11/24/2008	mh
Consulted with Jerry Lorengo regarding Declaration	10/07/09	mh
Consulted with Lizz Bolden regarding Declaration	10/07/09	mh
Updated East Search	10/07/09	mh
Updated East Search History	4/12/10	mh
Updated EAST Search	7/30/10	mh

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner
501	55, 65, 66	7/29/10	mh

Attorney Docket No. : ADP-231 US PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Adam J. G. Ellison
Appl. No.	:	11/478,493
Filed	:	June 28, 2006
For	:	FINING OF BOROALUMINO SILICATE GLASSES
Examiner	:	M. Hoban
Group	:	1793

Date of mailing of Notice of Allowance and Fee(s) Due: August 10, 2010

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

Applicant notes that his $\Sigma[RO]/[Al_2O_3]$ limitation, in relevant part, reads "$1.00 \leq \Sigma[RO]/[Al_2O_3]$" (independent Claims 1 and 6) or "$\Sigma[RO]/[Al_2O_3] \geq 1.00$" (independent Claim 9), and thus includes the case where $\Sigma[RO]/[Al_2O_3]$ equals unity. More generally, applicant assumes that the Examiner's Reasons for Allowance were not intended to, and do not affect, the scope of his claims as written, including his right to rely on the doctrine of equivalents in connection with those claims. The Examiner is requested to notify applicant if this understanding is incorrect.

Respectfully submitted,

Date: November 4, 2010

/Maurice M. Klee/

Maurice M. Klee, Ph.D.
Reg. No. 30,399
Attorney for Applicant
1951 Burr Street
Fairfield, CT 06824
(203) 255-1400

Electronic Acknowledgement Receipt

EFS ID:	8771520
Application Number:	11478493
International Application Number:	
Confirmation Number:	5778
Title of Invention:	FINING OF BOROALUMINO SILICATE GLASSES
First Named Inventor/Applicant Name:	Adam J.G. Ellison
Customer Number:	22928
Filer:	Maurice M. Klee/Anya Klee
Filer Authorized By:	Maurice M. Klee
Attorney Docket Number:	ADP-231 (SP05-073)
Receipt Date:	04-NOV-2010
Filing Date:	28-JUN-2006
Time Stamp:	15:52:49
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Post Allowance Communication - Incoming	adp231_US_a_Comments.pdf	20080 375c83c349d3e94e72f8d45c92c379a02921d81d	no	1

Warnings:	
Information:	

Total Files Size (in bytes):	20080

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

22928 7590 08/10/2010

CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

Susan M. Kane	(Depositor's name)
Susan M. Kane	(Signature)
November 5, 2010	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	06/28/2006	Adam J.G. Ellison	ADP-231 (SP05-073)	5778

TITLE OF INVENTION: FINING OF BOROALUMINO SILICATE GLASSES

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1510	$300	$0	$1810	11/10/2010

EXAMINER	ART UNIT	CLASS-SUBCLASS
HOBAN, MATTHEW E	1793	501-066000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Thomas R. Beall
2 Maurice M. Klee, Ph.D.
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Corning Incorporated

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Corning, New York

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**

☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 03-3325 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date November 5, 2010

Typed or printed name Thomas R. Beall Registration No. 40,424

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Electronic Patent Application Fee Transmittal

Application Number:	11478493
Filing Date:	28-Jun-2006
Title of Invention:	FINING OF BOROALUMINO SILICATE GLASSES
First Named Inventor/Applicant Name:	Adam J.G. Ellison
Filer:	Thomas Russell Beall/Susan Kane
Attorney Docket Number:	ADP-231 (SP05-073)

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl issue fee	1501	1	1510	1510
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1810**

Electronic Acknowledgement Receipt

EFS ID:	8780275
Application Number:	11478493
International Application Number:	
Confirmation Number:	5778
Title of Invention:	FINING OF BOROALUMINO SILICATE GLASSES
First Named Inventor/Applicant Name:	Adam J.G. Ellison
Customer Number:	22928
Filer:	Thomas Russell Beall/Susan Kane
Filer Authorized By:	Thomas Russell Beall
Attorney Docket Number:	ADP-231 (SP05-073)
Receipt Date:	05-NOV-2010
Filing Date:	28-JUN-2006
Time Stamp:	15:12:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1810
RAM confirmation Number	1552
Deposit Account	033325
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	20101105_SP05-073_US_Issue_Fee_Transmittal_Ltr.pdf	1063524 f9b70838964a1adc2a99367772f6a82b62709346	no	1
Warnings:					
Information:					
2	Fee Worksheet (PTO-875)	fee-info.pdf	32129 dbde7cae603d751be3b449d3fc321459a120069e	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1095653		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/478,493	12/14/2010	7851394	ADP-231 (SP05-073)	5778

22928 7590 11/23/2010

CORNING INCORPORATED
SP-TI-3-1
CORNING, NY 14831

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 101 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Adam J.G. Ellison, Painted Post, NY;

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Number: 7851394		
Patentees:	Adam J. Ellison	Confirmation No.: 5778
Serial No:	11/478493	Group Art Unit: 1793
Filed:	June 28, 2006	Examiner: Matthew E. Hoban
For:	FINING OF BOROALUMINO SILICATE GLASSES	

REQUEST FOR CERTIFICATE OF CORRECTION FOR

PTO MISTAKE PURSUANT TO 35 U.S.C. § 254 AND 37 C.F.R. § 1.322

Commissioner for Patents
Attention: Certificate of Correction Branch
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is a request for the issuance of a Certificate of Correction in the above-identified patent. Form PTO 1050 is appended. The correction(s) involve(s) page(s) .

The mistake(s) identified in the appended Form occurred through the fault of the Patent Office, as clearly disclosed by the records of the application which matured into this patent.

Issuance of the Certificate of Correction is requested.

Date: January 14, 2011

Respectfully submitted,
CORNING INCORPORATED

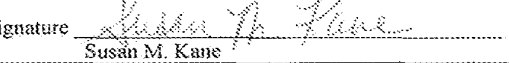


Thomas R. Beall
Attorney/Agent for Applicant
Registration No.: 40,424
Corning Incorporated
Intellectual Property Department
Mail Stop: SP-TI-03-1
Corning, NY 14831
Phone: (607) 974-3921

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this paper and/or fee or charge authorization is being transmitted to Mail Stop Certificate of Correction Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on January 14, 2011, via:

- ☐ Express Mail Post Office to Addressee service of the United States Postal Service under 37 CFR §1.10 (Express Mail Label No. _____);
- ☐ depositing with the United States Postal Service with sufficient postage as first class mail under 37 CFR §1.8;
- ☐ Facsimile Transmission under 37 CFR §1.6(d) (Facsimile No. _____);
- ☐ the Electronic Filing System of the U.S. Patent and Trademark Office under 37 CFR §1.6(a)(4)

Signature 
Susan M. Kane

Revised: February 2, 2009

(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7851394
DATED : December 14, 2010
INVENTOR(S) : Adam James Ellison, et al
CONF. No. : 5778

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

No.	*Col.*	*Line*	*Description*
1	21	38	Please delete "Al_2O_3: 19.0-12.0" and add --Al_2O_3: 9.0-12.0--

MAILING ADDRESS OF SENDER:

Corning Incorporated
Intellectual Property Department
Mail Stop: SP-TI-3-1
Corning, NY 14831

PATENT NO. 7851394

No. of additional copies 1

Electronic Acknowledgement Receipt

EFS ID:	9234322
Application Number:	11478493
International Application Number:	
Confirmation Number:	5778
Title of Invention:	FINING OF BOROALUMINO SILICATE GLASSES
First Named Inventor/Applicant Name:	Adam J.G. Ellison
Customer Number:	22928
Filer:	Thomas Russell Beall/Susan Kane
Filer Authorized By:	Thomas Russell Beall
Attorney Docket Number:	ADP-231 (SP05-073)
Receipt Date:	14-JAN-2011
Filing Date:	28-JUN-2006
Time Stamp:	14:07:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Certificate of Correction	20110114_SP05-073_US_Request_for_Certificate_of_Correction.pdf	548115 e08bc55f9b97ca3bcec6be93807de4ded5390a1	no	2
Warnings:					
Information:					

Total Files Size (in bytes):	548115

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,851,394 B2
APPLICATION NO. : 11/478493
DATED : December 14, 2010
INVENTOR(S) : Adam James Ellison et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Col.	Line	
21	38	Please delete "Al_2O_3: 19.0-12.0" and add --Al_2O_3: 9.0-12.0--

Signed and Sealed this
Thirty-first Day of May, 2011

David J. Kappos
Director of the United States Patent and Trademark Office