

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CAIHONG DISPLAY DEVICES CO., LTD.,
Petitioner

v.

CORNING INCORPORATED,
Patent Owner

Case IPR2025-01017
U.S. Patent No. 8,642,491

DECLARATION OF DR. RICHARD BROW

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Corning Incorporated EX2007
Caihong Display Devices v. Corning
IPR2025-01017

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I, Dr. Richard Brow, hereby declare as follows.

I. INTRODUCTION

1. I have been retained as an expert witness on behalf of Patent Owner Corning Incorporated (“Patent Owner”) for the above-captioned *inter partes* review (IPR). I am being compensated for my time in connection with this IPR at my standard consulting rate, which is \$200.00 per hour.

2. I understand that this Declaration accompanies a Patent Owner Preliminary Response involving U.S. Patent No. 8,642,491 (“the ’491 patent”) (EX1001), which resulted from U.S. Application No. 12/965,032, filed on December 10, 2010, and which is a continuation of U.S. Application No. 11/478,493, filed on June 28, 2006 (now the U.S. Patent No. 7,851,394). I understand that the ’491 patent ultimately claims priority to U.S. Provisional Application No. 60/694,478, filed on June 28, 2005. I understand that the effective priority date for the ’491 patent is no later than June 28, 2005, which is the filing date for this provisional application. I refer to this date throughout for purposes of this declaration.

3. In preparing this Declaration, I have reviewed the ’491 patent, the Petition filed in the above-captioned *inter partes* review, and each of the documents cited herein, in light of general knowledge in the art as of June 28, 2005. In formulating my opinions, I have relied upon my experience, education,

and knowledge in the relevant art. In formulating my opinions, I have also considered the viewpoint of a person of ordinary skill in the art (“POSA”), as defined further below in Section V, as of June 28, 2005, in light of general knowledge in the art.

II. MY BACKGROUND AND QUALIFICATIONS

4. I am currently the Curators’ Distinguished Professor Emeritus of Ceramic Engineering in the Department of Materials Science and Engineering at Missouri University of Science and Technology (Missouri S&T). I first joined Missouri S&T in 1998 as a Professor of Ceramic Engineering. At the same time, I became a Senior Investigator in the Materials Research Center, and I continue to hold that position today. In 2008, I became a Research Investigator in the Center for Biomedical Research (CBR). I was CBR Interim Director, then Director, from 2018 until 2021.

5. My research at Missouri S&T involves characterizing the structure and properties of oxide glasses and glass-ceramic materials used for a wide range of engineering applications. The research that I have directed, performed, and advised on has been sponsored by the National Science Foundation, the National Institutes of Health, the Department of Energy, the Department of Education, the Federal Highway Administration, the Department of Transportation, Lawrence Livermore National Lab, Pacific Northwest National Lab, Sandia National Labs,

and a variety of industrial companies, among others. I have published over 185 papers in peer-reviewed archival journals and 74 conference proceedings. I have supervised 18 completed doctoral theses and 20 master-of-science theses. I hold 17 US patents, four international patents, and four pending patent applications on glasses for a variety of engineering applications, including U.S. Patent No. 9,530,991 B2, directed towards alkali-free, alkaline earth borosilicate glasses.

6. My *curriculum vitae* is submitted herewith as EX2008.

7. I have developed and taught undergraduate courses at Missouri S&T on glass science and technology, materials processing and characterization, glass engineering, ceramic engineering, and kinetics of materials; and graduate-level courses on glass science, biomedical materials, and optical materials.

8. I attended Alfred University in Alfred, NY, where I received a Bachelor of Science degree in ceramic engineering in 1980, and a Master of Science degree in glass science in 1982. I received a Doctor of Philosophy degree in ceramic science from The Pennsylvania State University in 1985.

9. After earning my doctorate, I worked for nearly 13 years as a member of the Technical Staff at Sandia National Laboratories in Albuquerque, New Mexico before joining the faculty at Missouri S&T.

10. I have received several honors and awards throughout my career. For instance, in 1994, I received the Karl Schwartzwalder Professional Achievement in

Ceramic Engineering Award from the American Ceramic Society (“ACerS”). This is an award given annually to “the nation’s outstanding young ceramic engineer.” In 1996, I became the first American recipient of the International Commission on Glass’s Gottardi Prize, for “outstanding contributions to the field of glass science.” In 2004, I was awarded the George W. Morey Award for “new and original work in the field of glass science and technology” by ACerS. In 2016, I received the N.F. Mott Award “for outstanding contributions to the science of non-crystalline solids” from the *Journal of Non-Crystalline Solids*. In 2021, I was elected to the World Academy of Ceramics for “making an internationally renowned significant contribution to the advancement of ceramics culture, science, and technology.” I have been named an ACerS Fellow (1997) and Distinguished Life Member (2020), and a Fellow of the Society for Glass Technology (2005). And I served as President of ACerS from 2012-13.

III. SUMMARY OF OPINIONS

11. I have been asked to consider whether, as of June 28, 2005, the prior art that Petitioner and Dr. Ernst cite under Ground 1 would have rendered the challenged claims of the ’491 patent obvious. In view of the state of the art as of June 28, 2005, it is my opinion that Dr. Ernst fails to show that a POSA would have found the challenged claims obvious over the prior art. For claims 1 and 13 in Ground 1, a POSA would not have been motivated to substitute BaO with SrO in

Miwa '535's Embodiment 15 as proposed by Dr. Ernst. In the art of glass compositions, changes in oxide amounts (for example, alkaline earth oxide amounts) do not follow a simple one-to-one substitution. Rather, a change in one oxide amount often leads to a cascading effect on the influence of other oxides and material properties of the glass. Any change to any ingredient of a glass composition has an effect—often an unpredictable effect—on the delicate balance of the overall formulation. And contrary to Dr. Ernst's arguments, a POSA would not have used ionic field strength as a driving factor for modifying a glass composition. Also for claim 13 in Ground 1, a POSA would not have been motivated to modify the Sb_2O_3 mol% in Miwa '535 in view of JP '741 with any reasonable expectation of success.

12. I have also been asked to consider whether, as of June 28, 2005, the prior art that Petitioner and Dr. Ernst cite under Ground 2 would have rendered the challenged claims of the '491 patent obvious. It is my opinion that Dr. Ernst fails to show that a POSA would have found the challenged claims obvious over the prior art. A POSA would not have been motivated to substitute BaO with SrO in JP '643's Sample 5 as proposed by Dr. Ernst for the same reasons as those discussed herein for Ground 1. Further, a POSA would not have been motivated to modify the Sb_2O_3 mol% in JP '643 in view of JP '741 to arrive at claims 1 and 13 of the '491 patent with any reasonable expectation of success.

13. Finally, for Ground 3, I have been asked to consider whether Embodiment 8 of Miwa '377 anticipates claim 13 of the '491 patent. As discussed below, the Petition and Dr. Ernst fail to show that Miwa '377's Embodiment 8 expressly or inherently discloses a liquidus viscosity of greater than or equal to 100,000 poise, which I understand means the Petition fails to establish that Miwa '377 anticipates the claimed invention.

IV. LIST OF DOCUMENTS CONSIDERED

Exhibit No.	Description
EX1001	U.S. Patent No. 8,642,491 ("the '491 Patent")
EX1002	Prosecution History of the '491 Patent
EX1003	Declaration of Dr. Frank Ernst
EX1004	JP2004-189535A ("Miwa '535") Certified Translation
EX1005	JP1998059741 ("JP-741") Certified Translation
EX1006	U.S. 2005/0101469 ("Peuchert '469")
EX1007	JP2002308643 ("JP '643") Certified Translation
EX1008	JP2003192377 ("Miwa '377") Certified Translation
EX1009	Introduction to Glass Science and Technology, 2 nd Ed. (2005)
EX1010	Foshan Ceramics Research Institute Testing Co., Ltd, Test Report: Sample #5
EX1011	Foshan Ceramics Research Institute Testing Co., Ltd, Test Report: Sample #6
EX1012	<i>Curriculum Vitae</i> of Dr. Frank Ernst
EX1013	U.S. Patent No. 4,018,965
EX1014	U.S. PG PUB 2004/0224834
EX1015	W. Vogel, Glass Chemistry, 2 nd Ed., Chapter 4: Classical Theories of G Structure, Springer-Verlag (1994)

Exhibit No.	Description
EX2009	Kim, K.D., "Influence of BaO/(SrO+BaO) on melt properties in R2O-RO-SiO2 glasses for plasma display panel substrates," <i>Glass Technol.</i> , 41(5):161-164 (2000)
EX2010	Shannon, R.D. & Prewitt, C.T., "Effective Ionic Radii in Oxides and Fluorides," <i>Acta Cryst.</i> , B25:925-946 (1969).
EX2011	Mysen, B.O., et al., "The structural role of aluminum in silicate melts: a Raman spectroscopic study at 1 atmosphere," <i>American Mineralogist</i> , 66:678-701 (1981).
EX2012	Scarfe, C.M., "Viscosity-temperature relationships at 1 atm in the system diopside-anorthite," <i>American Mineralogist</i> , 68:1083-1088 (1983).
EX2013	Wallenberger, F.T., et al., "Design of energy and environmentally friendly fiberglass compositions derived from the quaternary SiO2-Al2O3-CaO-MgO phase diagram - Part I: Structures, properties and crystallization potential of eutectic and selected multi-oxide e-glass compositions," <i>Melt Chemistry, Relaxation, and Solidification Kinetics of Glasses</i> (2005)
EX2014	Darwish, H. & Gomaa, M.M., "Effect of compositional changes on the structure and properties of alkali-alumino borosilicate glasses," <i>Journal of Materials Science: Materials in Electronics</i> , 17:35-42 (2006)
EX2015	Kaur, N., et al., "Conductivity, dielectric, and structural studies of (30-x) SrO-xBaO-10Al2O3-45SiO2-5B2O3-10Y2O3 (5 ≤ x ≤ 25) glasses," <i>Ionics</i> , 24:2343-2353 (2018)
EX2016	Zanotto, E.D. & Coutinho, F.A.B., "How many non-crystalline solids can be made from all the elements of the periodic table?," <i>Journal of Non-Crystalline Solids</i> , 347:285-288 (2004).
EX2017	Shelby, J.E., "Introduction to Glass Science and Technology," <i>The Royal Society of Chemistry</i> , 2nd Ed. (2005)

V. PERSON OF ORDINARY SKILL IN THE ART (“POSA”)

14. As an expert, I have offered opinions throughout this Declaration from the perspective of a POSA. I understand that a POSA is a hypothetical person who is presumed to be aware of all pertinent art, who thinks along conventional wisdom in the art, and is a person of ordinary creativity. I also understand that the following factors are pertinent to the determination of the level of ordinary skill: (1) educational level and any specialties of the inventor(s), (2) types of problems encountered in the art, (3) prior-art solutions to those problems, (4) rapidity with which innovations are made, (5) sophistication of the technology, (6) educational level of active workers in the field, and (7) nature of any testing described in the patent (and skills required of those doing such testing).

15. I understand that Dr. Ernst’s definition of a POSA is a person who “would have comprehensive knowledge and deep understanding of the materials science aspects and the underlying physical, chemical, and mathematical concepts of the science of glasses, as relevant to the ‘491 patent. For example, this would include (but is not limited to) the concepts of liquidus temperature, viscosity, coefficient of thermal expansion, strain point, density. Further, a POSITA would have considerable understanding of and experience with design, synthesis, and characterization of silicate, borosilicate, aluminosilicate and boroaluminosilicate glasses.” EX1003, ¶24.

16. When applying the pertinent factors to the determination of the level of ordinary skill, it is my opinion that a POSA would have had a bachelor's degree in materials science, geology, chemistry, or a comparable field of study, and at least two to three years of research or industrial experience with the design, manufacturing, characterization, and testing of glasses, including oxide glasses. Alternatively, a POSA would have had a master's degree or higher in the same fields of study.

17. Based on my education and experience, I meet the criteria for a POSA, under either Dr. Ernst's or my own definition.

18. Upon my review of Dr. Ernst's *curriculum vitae* (EX1012), it is my opinion that Dr. Ernst does not meet his own definition of a POSA. Specifically, there is no indication that Dr. Ernst has "considerable ... experience with design, synthesis, and characterization of silicate, borosilicate, aluminosilicate, and boroaluminosilicate glasses," as described by Dr. Ernst in his declaration. EX1003, ¶24. Dr. Ernst appears to have experience with oxide materials, particularly interfaces of oxides with metals, for example, based on some studies of Cu_2O . See EX1012, 16 (#74). That said, there is no evidence that Dr. Ernst has ever performed research on, written about, spoken on, or taught classes with topics on silicate, borosilicate, aluminosilicate, and boroaluminosilicate glasses. Indeed, the word "glass" does not appear once on his CV. His lack of experience in the field of

glass compositions would manifest itself in a lack of appreciation of: (i) the viscosities of glass melts, which are many, many orders of magnitude greater than slag or metal melts, (ii) the influence of glass structure on glass properties, and (iii) the importance of particular oxide concentrations (e.g., MgO, $\Sigma[\text{RO}]/[\text{Al}_2\text{O}_3]$, SnO_2 , As_2O_3 , and Sb_2O_3) and raw materials (e.g., boric acid, carbonates, and oxides) on the evolution of batch reactions, melt viscosity, and fining.

VI. LEGAL BASIS FOR MY ANALYSIS

19. In formulating my opinions set forth in this Declaration, I applied the following legal principles.

A. Claim Construction

20. I understand that in an IPR, patent claim terms are given their ordinary and customary meanings as understood by a POSA at the time of the invention, in view of the patent's specification and its prosecution history—unless the patent explicitly defines the claim term. I also understand that when a patent explicitly defines a claim term in the specification, the patent's definition controls.

21. I understand that claims 1 and 13 are the independent claims in the '491 patent. I also understand that claims 2-12 and 24 depend from claim 1 and claims 14-23 depend from claim 13. I understand that a dependent claim contains all limitations of the claim from which it depends. Thus, I understand that claims

2-12 and 24 contain all of the limitations of claim 1 and claims 14-23 contain all of the limitations of claim 13.

B. Obviousness

22. I understand that an obviousness analysis involves comparing a claim to the prior art to determine whether the claimed subject matter would have been obvious to a POSA in view of the prior art and general knowledge in the prior art at the time of the patent's priority date (here, June 28, 2005). I understand that obviousness must be assessed from the viewpoint of a POSA at the time of the invention. I further understand that to establish obviousness, a party must perform the following factual inquiries: (a) determining the scope and content of the prior art; (b) ascertaining the differences between the claimed invention and the prior art; and (c) resolving the level of skill in the art. I understand that, in determining the scope and content of the prior art and ascertaining the differences between the claimed invention, a patent challenger must specify where each element of the claim is found in the prior art.

23. I understand that one way of establishing obviousness is by establishing that a POSA would have had both (i) a reason to modify or combine the teachings of the prior art to achieve the claimed invention and (ii) a reasonable expectation of success in doing so. I understand that the reason to combine prior-art references can come from a variety of sources, not just the prior art itself or the

specific problem the patentee was trying to solve. And I understand that the references themselves need not provide a specific hint or suggestion of the alteration needed to arrive at the claimed invention; the analysis may include recourse to logic, judgment, and common sense available to a person of ordinary skill that does not need to be explicit in any reference.

24. I understand that a “reasonable expectation of success” is assessed in view of the prior art and general knowledge in the art from the viewpoint of a POSA at the time of the patent’s priority date, and it does not require an absolute certainty of success. Furthermore, I understand that determining whether the prior art would have suggested to those of ordinary skill in the art to carry out the claimed invention with a reasonable expectation of success must be done after determining that the claimed elements are present in the prior art.

25. I also understand that, before reaching a conclusion that the claimed invention would have been obvious, one must consider any objective evidence of non-obviousness if it is available. The objective evidence of non-obviousness can include evidence of commercial success attributable to the claimed invention, evidence of industry praise for the claimed invention, evidence of a long-felt need that was solved by the claimed subject matter, evidence that others copied the claimed subject matter, or evidence that the claimed subject matter achieved an unexpected, superior result relative to the closest prior art. I understand that such

evidence must have a nexus, or causal relationship, to the claimed subject matter beyond what was available in the prior art, and must be commensurate in scope with the patent claim(s) at issue.

C. Anticipation

26. My understanding is that a patent claim is invalid as anticipated if each and every limitation of that claim: (1) is disclosed, either explicitly or inherently, in a single prior-art reference; (2) is already in practice in the industry in a single process or method; (3) is already in a single marketed product; or (4) is otherwise previously invented. For a step or limitation to be inherent in a reference, I understand that the step or limitation must necessarily always occur or be present when one follows the teachings of the reference. I am informed that for a reference to be considered as anticipating it must disclose the relevant technology in a manner such that a person of ordinary skill in the art would be able to carry out or utilize the technology that the reference describes without having to undertake undue experimentation.

VII. CLAIMS 1 AND 13 WOULD NOT HAVE BEEN OBVIOUS IN VIEW OF MIWA '535 AND PEUCHERT '469.

27. In the invalidity grounds, the Petition and Dr. Ernst argue that claims 1 and 13 are rendered obvious by Miwa '535 alone (claim 13) or by the combination of Miwa '535 and Peuchert '469 (claim 1). Pet., 10. Miwa '535

describes 20 glass compositions (not counting the two comparative examples) and their associated properties. EX1004, ¶¶39-42. Of these 20 compositions (referred to as “Embodiments” in Miwa), the Petition and Dr. Ernst’s analysis centers around a single embodiment—Embodiment 15. Pet., 22-23, 33-34; EX1003 ¶¶78-81, 183-184.

A. A POSA would not have been motivated to completely substitute BaO for SrO in Miwa ’535’s Embodiment 15 to arrive at the glass of claim 1.

28. For claim 1 of the ’491 patent, Dr. Ernst concedes that Embodiment 15 of Miwa ’535 does not disclose “the mole fraction of BaO” claimed. EX1003, ¶81. To make up for this deficiency, Dr. Ernst claims that “when Miwa ’535 and Peuchert ’469 are understood, it would be reasonable for a POSITA to optimize and/or optimize [sic] the fraction of BaO, including having a mole- or mass fraction of BaO equal to zero. This overlaps the BaO mole fraction of $X_{\text{BaO}} = (0 \text{ .. } 0.1) \text{ mol\%}$ in limitation 1[g].” EX1003, ¶91. This modification to Miwa’s Embodiment 15 forms the basis for the Petition and Dr. Ernst’s obviousness ground 1, with Dr. Ernst and the Petition arguing that Peuchert ’469 provides the basis for the substituting all 0.21 mol% of the BaO in Miwa ’535’s Embodiment 15 for 0.31 mol% SrO. Pet, 25-26; EX1003, ¶¶85-89.

29. Dr. Ernst opines “[t]he approach of replacing BaO with SrO is obvious from the known theory described in paragraphs 72-75 [of Exhibit 1003]

and would have had a reasonable expectation of success.” EX1003, ¶89. The relevant portions of paragraphs 73-75 allege:

[A] POSITA would know that SrO and BaO play *similar* roles of network modifiers in the atomistic structure of silicate glass. This is understood from the network theory introduced by Dietzel, EX1015, Section 4.4. Assuming that the anion is oxygen, the effect of a single cation, such as Sr^{2+} or Ba^{2+} , [sic] is characterized by its electric-field strength $F = Z_c/a^2$, where Z_c is the cation charge ((2– for Sr or Ba)¹ and $a=r_c+r_a$ is the distance between the (point-like) nuclei of the anion (oxygen, radius r_a) and the cation (Sr or Ba, radius r_c). EX1015, Section 4.4, Table 4.2 shows corresponding data for the field strengths of Sr and Ba at the distance of an O^{2-} ion (highlighting added): ... Therefore, Sr and Ba play a *similar* role of network modifiers in the silicate glass structure. This information was well known at the time the ‘491 patent was filed. EX1003, ¶73-75 (emphasis in original).

30. This analysis is the only motivation that Dr. Ernst provides for his proposed modification to arrive at the claimed invention. He provides no support for why a POSA would want to eliminate BaO, nor does he provide support for

¹ This is presumed to be an error and that Dr. Ernst’s intended cation charge is 2+, not 2–.

why a POSA would have increased or adjusted only the SrO concentration to account for the decreased BaO.

31. I disagree that a POSA would have found it obvious to remove all of the BaO of Miwa's Embodiment 15 in favor of SrO. A POSA would not have been motivated to make this modification for multiple reasons. Contrary to Dr. Ernst's theory, a POSA would not have used ionic field strength as a driving force for substituting BaO for SrO in Miwa '535's glass composition. As discussed below, such a substitution was known to result in unpredictable, and oftentimes detrimental, changes to glass properties touted by Miwa '535. Because of this, a POSA would not have had a reasonable expectation of success in making Miwa's Embodiment 15 a Ba-free glass. What is more, Dr. Ernst fails to explain why a POSA would have selected Embodiment 15, from the 20 options provided by Miwa '535, for modification to the BaO and SrO amounts. Miwa's Embodiment 15 displayed the worst performance out of all of Miwa's embodiments in multiple glass property metrics. And based on technical literature, the proposed substitution of BaO with SrO would have, if anything, resulted in Miwa's Embodiment 15 performing even worse in terms of at least liquidus temperature and CTE.

1. **A POSA would not have considered ionic field strength as a proxy for an oxide's effect on a glass composition and its properties.**

32. Dr. Ernst's argument for why BaO and SrO can be substituted for one

another is overly simplistic and technically inaccurate. Dr. Ernst claims that BaO and SrO can be substituted for one another based on the “*similar* role of network modifiers” that they both play. EX1003, ¶75. Dr. Ernst explains that this “network modifying role” played by Ba²⁺ and Sr²⁺ is due to the similar ionic field strengths of the metal cations Sr²⁺ and Ba²⁺: “the field strengths of Sr and Ba are both ‘weak’ and very *similar*: 28 nm⁻² and 24 nm⁻², respectively.” EX1003, ¶74 (emphasis in original).

33. Contrary to Dr. Ernst’s assertion, a POSA would have known that ionic field strength does not paint the entire picture when it comes to various elemental impacts on glass properties. A POSA would not have considered the similar ionic field strengths of these elements as having the same effect on glass properties in light of empirical data showing that the ratio of BaO to SrO in a glass composition affects its properties.

34. A POSA would have been aware that ionic field strength is a characteristic of metal ions, and that ionic field strength affects the bonding interactions with oxygen ions in the glass. However, ionic field strength does not provide enough information to make precise predictions of the impact of glass compositional changes on glass properties. Indeed, Dr. Ernst does not attempt to draw any connection or relationship between a given cation’s ionic field strength and that metal oxide’s impact on glass properties. Such a connection based on

ionic field strength alone would be tenuous at best. Additional considerations independent of field strength include network anion charge balancing and bond configurations with cation valence electrons, both of which vary between metal cations independent of ionic field strength.

35. A clear example of the insufficiency of only considering ionic field strength comes in the teachings of Kim (EX2009). Kim is a systematic study of the “[i]nfluence of BaO/(SrO+BaO) [also described in Kim as BaO/RO] on melt properties in R₂O-RO-SiO₂ glasses for plasma display panel substrates.” EX2009, 161. Kim teaches that varying BaO and SrO concentrations in glass compositions results in changes to the “viscosity and liquidus temperature” of the glasses. EX2009, 161. Kim goes on to explain that “the lowering of viscosity by substitution of Ba²⁺ for Sr²⁺ *cannot be explained simply in terms of the field strength* or polarisability of the modifier.” EX2009, 162 (emphasis added). Kim’s teachings highlight that there is more to the impact of BaO vs. SrO in glasses than the “modifier” behavior that Dr. Ernst espouses. Dr. Ernst seriously overstates the motivation a POSA would have had to remove BaO in favor of SrO based on the overly simplistic view of two cations (Ba²⁺ and Sr²⁺) having allegedly interchangeable ionic field strengths.

36. Another example showing the glaring insufficiency in relying on ionic field strength comes in the comparison between other oxides formed from cations

having similar ionic field strengths, for example, ZnO and MgO. As noted above, Dr. Ernst claims that since Sr^{2+} and Ba^{2+} both have similar field strength based on a difference of $0.04 \text{ \AA}^{-2}$ ($0.28 \text{ \AA}^{-2}$ and $0.24 \text{ \AA}^{-2}$, respectively), SrO and BaO are simply interchangeable within a glass composition. *See* EX1003, ¶72-75. That said, using the methodology presented for calculating field strength in EX1015, where in $F = Z_c / (r_c + r_{\text{O}^{2-}})^2$, and where Z_c = the charge on the cation, r_c = the radius of the cation, and $r_{\text{O}^{2-}}$ is the radius of oxygen (here, $1.4 \text{ \AA}$, as described in EX1015, 60 and in EX2010, 927), Zn^{2+} and Mg^{2+} also have similar ionic sizes ($\text{Mg}^{2+}(\text{VI}) = 0.72 \text{ \AA}$, $\text{Zn}^{2+}(\text{VI}) = 0.745 \text{ \AA}$, EX2010, 928-29), and therefore have ionic field strengths that differ by less than $0.04 \text{ \AA}^{-2}$ ($0.44 \text{ \AA}^{-2}$ and $0.43 \text{ \AA}^{-2}$, respectively),² but display materially different properties as oxides. The melting point of MgO is almost 40% greater than ZnO (3125 K vs 2248 K, respectively), so these oxides can have significantly different effects on glass properties like high temperature viscosities (e.g., melt viscosity) and liquidus temperature. A second illustrative example is that of CaO and CdO. Ca^{2+} and Cd^{2+} have similar ionic radii ($\text{Ca}^{2+}(\text{VI}) = 1.00 \text{ \AA}$, $\text{Cd}^{2+}(\text{VI}) = 0.95 \text{ \AA}$, EX2010, 928-29), and so have ionic field strengths that differ by less than $0.04 \text{ \AA}^{-2}$ ($0.35 \text{ \AA}^{-2}$ and $0.36 \text{ \AA}^{-2}$, respectively), yet their

² A sample calculation for MgO is shown here: $\text{IFS} = Z_c / (r_c + r_{\text{O}^{2-}})^2 = 2 / (0.72$

$\text{\AA} + 1.4 \text{ \AA})^2 = 2 / (2.12 \text{ \AA})^2 = 2 / (4.49 \text{ \AA}^2) = 0.44 \text{ \AA}^{-2}$.

respective oxides have much different properties. CaO melts at 2845 K whereas CdO melts between 1173 K and 1273 K, so these oxides would have significantly different effects on the properties of a glass. These comparisons illustrate why a POSA would not have used ionic field strength as an overriding factor for modifying a glass composition, and instead would have looked to tangible, empirical data showing target glass properties, such as liquidus temperature, high temperature viscosity, and CTE at given oxide concentrations, as discussed below.

37. Further, a POSA would have understood that experimental studies show that, when the total concentration of alkali or alkaline earth oxides is greater than that of Al_2O_3 (as is the case in Miwa '535's Embodiment 15), the amount of alkaline earth oxides equal to the amount of Al_2O_3 will be in charge-compensation roles, not network-modifier roles. This phenomenon was known as early as 1981, with Mysen (EX2011) teaching that "[t]he [glass] compositions studied have sufficient or excess alkali or alkaline earth contents to balance the charge of Al^{3+} in tetrahedral coordination," and with Scarfe (EX2012) teaching in 1983 that "[w]hen alumina is added [to a glass melt], aluminum goes into tetrahedral positions in the melt and calcium and magnesium provide charge balance." EX2011, 678; EX2012, 1086. In Miwa's Embodiment 15, the ratio of ΣRO (MgO , CaO , SrO , and BaO) to Al_2O_3 , as calculated by Dr. Ernst, is 1.20:1, EX1003, ¶93, meaning that most of the alkaline earth ions, including most of the Ba^{2+} and Sr^{2+} cations in Miwa '535's

Embodiment 15, would be acting as charge-balancing cations, rather than as network modifiers.

38. Network-modifying cations and charge-balancing cations play different roles in a glass structure. As taught by Mysen, “the activity of a metal cation such as Ca^{2+} may depend on whether it charge-balances aluminum or it simply forms nonbridging oxygens in the melt.” EX2011, 679. As an increasing fraction of larger divalent cations shift into charge-compensation roles, the overall concentration of nonbridging oxygens decreases, which in turn causes the formation of increasing numbers of strong Al-O-Si and Si-O-Si linkages. And this increasing number of strong Al-O-Si and Si-O-Si linkages has a significantly different impact on glass properties than what would be the case if an alkaline earth ion acted as a “network modifier.”

39. Dr. Ernst’s discussion of the motivation for substituting BaO with SrO is grounded in an argument that assumes a network modifying regime, but this regime is largely inappropriate given the high relative concentration of Al_2O_3 with respect to ΣRO . This incorrect assumption is an example of the insufficiency of Dr. Ernst’s offered motivation that a POSA would have had in modifying Miwa ’535’s Embodiment 15.

40. By relying on a metric that is not suitable for assessing the impact different oxides have on a glass composition like Miwa ’535’s Embodiment 15,

Dr. Ernst's logic for why a POSA would have been motivated to substitute one of these elements for the other is fundamentally flawed. Dr. Ernst fails to point to any reason that a POSA would have wanted to reduce, let alone eliminate, the concentration of BaO in Miwa '535's Embodiment 15, much less with any reasonable expectation of success. Dr. Ernst also fails to point to any other reason a POSA would have added an equivalent amount of SrO, and only SrO, into the composition over the ten other potential oxides listed in Miwa '535: SiO₂, Al₂O₃, B₂O₃, MgO, CaO, ZnO, ZrO₂, SnO₂, As₂O₃, and Sb₂O₃. In doing so, Dr. Ernst's testimony fails to justify the choices that he argues a POSA would have made.

2. Peuchert '469 would not have motivated a POSA to modify the mol% of BaO in Miwa '535's Embodiment 15.

41. The Petition and Dr. Ernst further attempt to bolster their argument by citing Peuchert '469. Pet. 26, EX1003, ¶¶90-91. According to the Petition and Dr. Ernst, Peuchert '469's disclosure of glass compositions with the “sum of the two heavy alkaline earth metal oxides SrO and BaO [being] preferably limited to a maximum of 4% by weight” would have helped motivate a POSA to change the mol% of BaO in Miwa '535's Embodiment 15. Pet., 26. Aside from citing Peuchert '469 as disclosing a maximum wt% of SrO and BaO, the Petition and Dr. Ernst provide no actual reason for why Peuchert '469 would have motivated a POSA to modify Miwa '535's Embodiment 15 at all, much less with a reasonable

expectation of success. Peuchert '469 does not disclose or suggest substituting BaO with SrO, much less disclose any interplay between these two oxides.

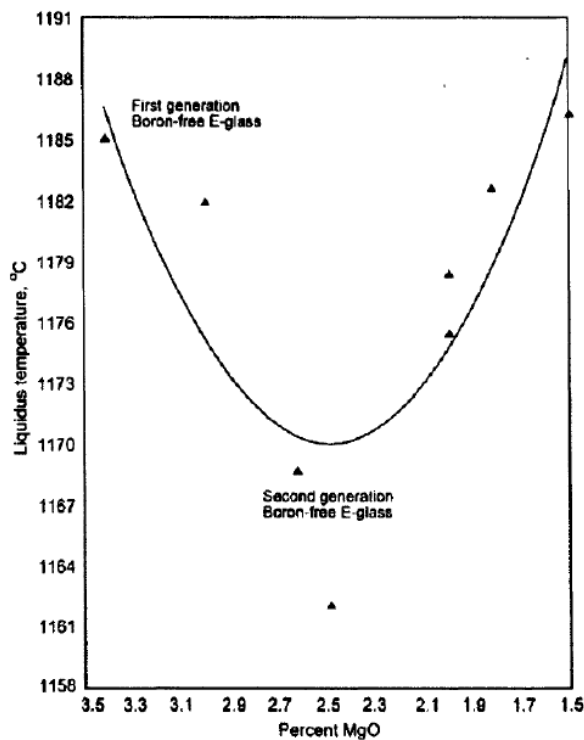
42. Further, the glasses disclosed in Peuchert '469 are from a compositional family significantly different from the glasses described in Miwa '535. Peuchert '469's glasses are based on the MgO-Al₂O₃-SiO₂ (MAS) system, diluted by small amounts of B₂O₃ and modified by CaO. In contrast, Miwa '535's glasses (and in particular Embodiment 15) are based on the CaO-Al₂O₃-SiO₂ (CAS) system, significantly diluted by B₂O₃ and modified by MgO. The minimum MgO concentration in Peuchert's examples is 8.1 wt% and the maximum B₂O₃ concentration is 6.5 wt%. EX1006, 4 (Table). These weight percentages are distinctly different from those described in Miwa '535. The range of MgO and B₂O₃ in Miwa '535's non-comparative Embodiments 1-20 are 0-1.3 wt% and 9.0-12.0 wt%, respectively. EX1004, ¶¶39-42. In addition, Peuchert '469 and Miwa '535 disclose non-overlapping ranges for glass density. The density of Peuchert '469's example glasses ranges from 2.447 g/cm³ to 2.53 g/cm³. EX1006, 4 (Table). The density of Miwa '535's example glasses ranges from 2.35 g/cm³ to 2.44 g/cm³. EX1004, ¶¶39-42. Because these compositions (and structures and properties) are so different, a POSA would not have considered Peuchert '469 for motivation to modify the BaO and/or SrO mole percentages in Miwa '535.

3. A POSA would have known that substituting BaO with SrO would have unpredictable, nonlinear effects on glass properties in Miwa '535's Embodiment 15.

43. In addition to improperly justifying the substitution of BaO with SrO using an oversimplified ionic field strength model for the impact of metal oxides on glass properties, Dr. Ernst also fails to account for the unpredictable, nonlinear effects that small changes in metal oxide composition can have on glass properties. For example, the impact of the “mixed alkaline earth effect” described by Kim (EX2009), wherein the presence of multiple alkaline earth species confers glass properties that the same amount of a single species would not confer, exemplifies such unpredictable, nonlinear effects. The fact that even small changes in glass composition could potentially have significant and unpredictable effects on glass properties was evidenced in technical literature at the time the '491 patent was filed, and continues to be evidenced in more recent literature. By ignoring this, Dr. Ernst fails to address key concepts that would have discouraged a POSA from his proposed modification of Miwa's Embodiment 15.

44. A POSA would have known that making small changes to alkaline earth metal oxides in glass compositions could result in nonlinear—and unpredictable—impacts on properties. Wallenberger (EX2013), published in 2004, shows that changing the weight percent for MgO in the SiO-Al₂O₃-CaO-MgO composition space creates non-linear effects on the liquidus temperature of the

glass, with the liquidus temperature curve exhibiting a parabolic trend that reaches a minimum at about 2.5 weight percent. As shown in Figure 1 of Wallenberger (reproduced below) changing the weight percent of MgO from about 3.5 weight percent to about 2.5 weight percent drops the liquidus temperature by 25°C, but a further decrease in MgO results in a parabolic increase in liquidus temperature.



EX2013, 184, FIG. 1.

45. Like Wallenberger, Kim teaches non-linear effects for small changes in alkaline earth metal oxide concentrations such as BaO and SrO. Kim teaches that “the viscosity and the liquidus temperature show a continuous decrease with increase of BaO [with respect to SrO]” for a plasma display panel glass composition. EX2009, 164. And Kim shows that the ratio of BaO to SrO can have

non-linear effects on the liquidus temperature, which do not necessarily follow a predictable pattern. Kim's data reported in Figure 3 (reproduced below) shows that varying the ratio of BaO to BaO+SrO between 0 and 1 creates a non-linear effect on liquidus temperature (T_l). EX2009, 162.

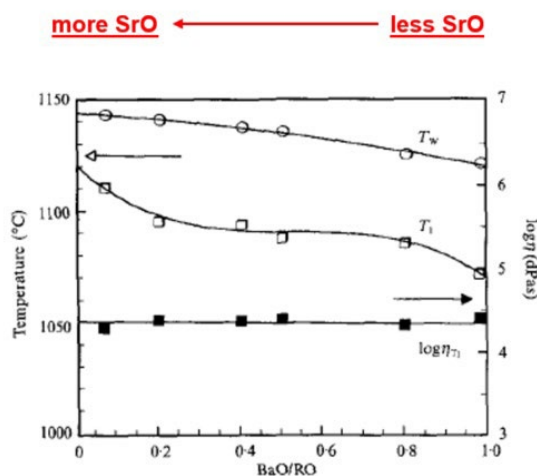
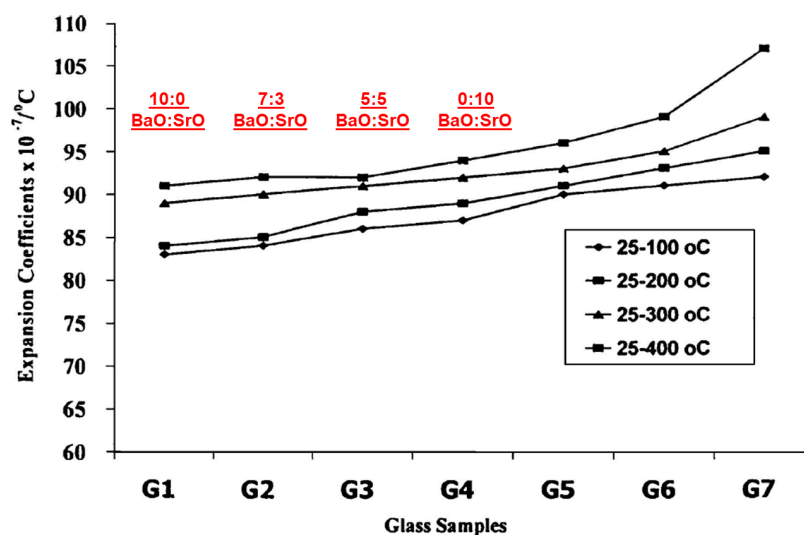


Figure 3. Liquidus temperatures (T_l), working temperature (T_w) and viscosity at liquidus temperature ($\log \eta_l$) as a function of BaO/RO

EX2009, 162, FIG. 3 (annotated).

46. Yet another example of nonlinear effects when substituting BaO with SrO comes from Darwish (EX2014), published in 2006. Darwish's data reported in Figure 2 (reproduced below) shows that the CTE values are not always predictably impacted in a linear fashion by a change in Ba/Sr ratio. For example, the change from G1 to G3 (BaO:SrO ratios of 10:0 and 5:5, respectively) increases CTE by $4 \times 10^{-7} \text{ } ^\circ\text{C}^{-1}$, from $84 \times 10^{-7} \text{ } ^\circ\text{C}^{-1}$ to $88 \times 10^{-7} \text{ } ^\circ\text{C}^{-1}$, measured over the temperature range 25-200 $^\circ\text{C}$. But further removing barium from G3 to G4 (BaO:SrO ratios of 5:5

and 0:10, respectively) causes a smaller increase over this temperature range, from $88 \times 10^{-7} \text{ }^{\circ}\text{C}^{-1}$ to $89 \times 10^{-7} \text{ }^{\circ}\text{C}^{-1}$. These nonlinear effects again demonstrate the unpredictability a POSA would have faced when considering swapping BaO for SrO.



EX2014, 38, FIG. 2 (annotated).

47. SrO and BaO have distinctly different effects on properties because they have different, not similar, ion properties. These different effects are evident in, for example, nonlinear—and often unpredictable—impacts on glass properties. Substituting even a small percentage of one alkaline earth oxide (for example, MgO, CaO, SrO, or BaO) for another alkaline earth oxide (for example, MgO, CaO, SrO, or BaO) can have significant, nonlinear (and potentially unpredictable) effects on significant properties of the glass. In light of these potentially non-linear,

unpredictable effects of varying even one metal oxide concentration in a glass composition, even if a POSA were to have varied just one metal oxide concentration in a given composition, a POSA would not have evaluated such changes in isolation. Rather, a POSA would have viewed the glass composition space holistically to evaluate how various oxide concentrations would affect the atomic structure of the glass, which influences the melt properties of the glass composition, and ultimately the properties of the resulting glass.

48. Indeed, the mixed alkaline-earth effect continued to be a topic of research after the priority date of the '491 patent. For example, Kaur (EX2015) teaches that the conductivity of glasses in the SrO-BaO-Al₂O₃-SiO₂-B₂O₃-Y₂O₃ system is maximized when an equal ratio of BaO and SrO are present in the glass. When this ratio deviates from 1:1, conductivity suffers. “The highest conductivity ($3.34 \times 10^{-6} \text{ S cm}^{-1}$), dielectric constant, and dielectric losses are observed in 15BS [equal BaO and SrO present] glass due to mixed alkaline earth metal oxides (modifier) effect.” EX2015, 2351. Kaur’s data is similar to data and comments reported by Kim with respect to the mixed-alkaline earth effect on the electrical resistivity for a BaO- and SrO-containing glass. Kim stated that:

The resistivity minima are positioned at $\text{BaO/RO} \approx 0.45$ and the magnitude of nonlinearity is independent of the temperature. The occurrence of minima or maxima in some properties except resistivity

against relative concentration of two alkaline earth oxides has been reported in several works and is called the mixed alkaline earth effect.

The resistivity minima in the present work show an opposite behaviour compared with the resistivity maxima in the mixed alkali effect.

EX2009, 163 (internal citations omitted).

49. These discussions in Kaur and Kim reinforce the knowledge that a POSA would have had when evaluating Miwa's Embodiment 15—even small changes in oxide concentrations for a given alkaline earth oxide in a glass composition can have nonlinear and unpredictable effects.

4. The literature teaches that substituting BaO with SrO as proposed by Dr. Ernst would have been detrimental to significant glass properties of interest in Miwa' 535's disclosure.

50. Technical literature available at the time of the '491 patent's filing date evidences that substituting BaO with SrO in a composition space like that of Miwa '535 could be detrimental to glass properties that Miwa '535 teaches are beneficial. For example, the literature taught that increasing the amount of SrO relative to BaO could at least tend to increase liquidus temperature and increase CTE. These two trends are directly contrary to Miwa '535's disclosure that these properties should have lower values. Liquidus temperature would have been a particularly important consideration for LCD glass sheets like that discussed in

Miwa '535, and could negatively affect the ability of the Miwa '535 glass to be formed into a defect free glass sheet.

51. Miwa '535 discloses the following preferences for liquidus temperature and CTE. “The liquid phase temperature is 1120 °C or less, so [the glass] also has excellent fusibility and formability.” EX1004, ¶47. “The coefficient of thermal expansion must be small in order to improve thermal shock resistance and reduce damage during the heat treatment process.” EX1004, ¶5.

52. With respect to liquidus temperature, Kim reported that “liquidus temperature[s] show a continuous decrease with increase of BaO [with respect to SrO].” EX2009, 164. This trend of increasing liquidus temperature with the replacement of BaO by SrO is evident in Kim’s Figure 3 (reproduced and annotated below), and is the exact opposite of what Miwa prefers.

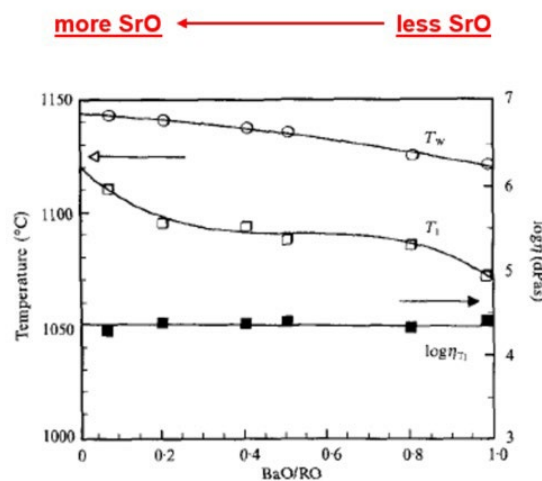
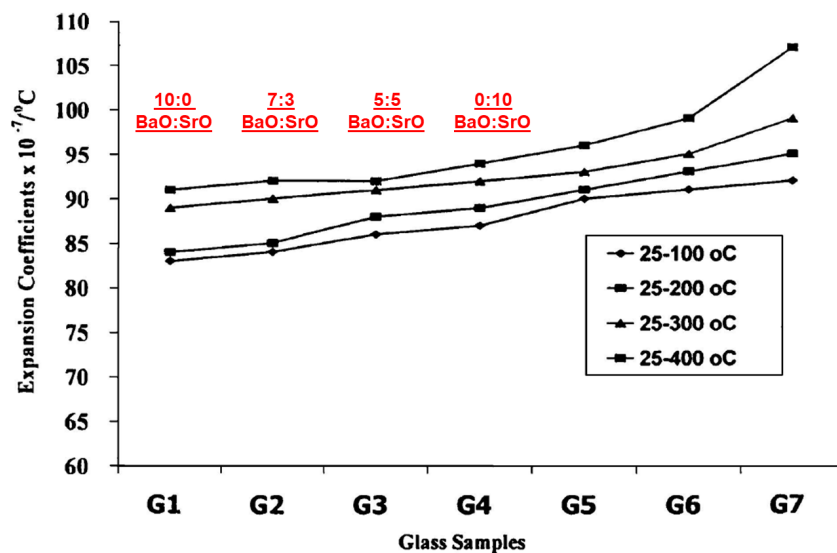


Figure 3. Liquidus temperatures (T_l), working temperature (T_w) and viscosity at liquidus temperature ($\log \eta_l$) as a function of BaO/RO

EX2009, 162, FIG. 3 (annotated).

53. With respect to CTE, the data reported in Darwish's Figure 2 (reproduced and annotated below) shows that increased SrO tends to increase CTE of an alkali-alumino borosilicate glass in every single glass composition tested by Darwish. This is, again, the exact opposite of what Miwa prefers.



EX2014, FIG. 2 (annotated).

54. In light of at least Kim and Darwish, a POSA would have understood that the substitution of BaO with SrO could have been counterproductive to achieving lower values of liquidus temperature and CTE as taught by Miwa '535. If anything, the literature teaches that Dr. Ernst's proposed substitution could have transformed Miwa '535's Embodiment 15 into a glass that is less moldable and more susceptible to thermal shock. It is also worth noting that Kim explicitly

teaches that “full replacement of SrO by BaO is desirable from the viewpoint of raw material cost and practical glass production.” EX2009, 161. Again, this is directly contrary to Dr. Ernst’s allegedly obvious substitution of BaO with SrO.

55. Further, a POSA would have known that reducing the number of oxide components in a glass composition often makes the melt more prone to crystallization, making it more difficult to produce a defect-free glass. This concept is explained in Zanotto (EX2016), which describes the “principle of ... confusion,” wherein melts with greater numbers of oxide components need to undergo more extensive solute redistribution to crystallize. EX2016, 287. In other words, additional compositional components “confuse” crystallization, which promotes glass creation. Zanotto states that “the so-called ‘principle of maximum confusion’ (it has been empirically established that multi-component compositions vitrify more easily than compositions containing only a small number of chemical elements) helps glass formation with combinations of many elements.” EX2016, 287.

56. As such, removing all of the BaO in a given glass composition and replacing it completely with SrO, as proposed by Dr. Ernst, would create a less compositionally complex glass. This less compositionally complex glass, in turn, would reduce the crystallization “confusion” exhibited by the melt, meaning that the melt could be more likely to crystallize and less likely to form a defect-free

glass when cooled below the liquidus temperature. This increased likelihood of crystallization would have discouraged a POSA from making Dr. Ernst's proposed modification to Miwa '535's Embodiment 15.

57. Indeed, Miwa '535 itself clearly values the presence of BaO in the glass composition. All but four of Miwa's 20 embodiments contain at least some amount of BaO. Miwa '535 does not highlight or otherwise specifically praise the four compositions lacking BaO (Embodiments 7-9 and 20), nor do these embodiments have noteworthy properties in the context of Miwa's disclosure.

58. In sum, Dr. Ernst oversimplifies and misstates similarities between BaO and SrO. Dr. Ernst incorrectly concludes that a POSA would have chosen BaO, out of all of the oxides listed in Miwa '535's Embodiment 15, to completely eliminate for SrO. Dr. Ernst fails to appreciate that a change in the distribution of alkaline earth oxides, such as the ratios of BaO and SrO, in a glass composition can have far-ranging and unpredictable outcomes on glass properties. The literature, and Miwa '535 itself, show that a POSA would have viewed such compositional changes as potentially having an unpredictable result on significant glass properties. Even if a POSA were to have considered modifying the amount of BaO and/or SrO present in Miwa '535's Embodiment 15, the literature would not have taught a POSA to implement Dr. Ernst's proposed modification, and even would have suggested the opposite (i.e., reducing the amount of SrO and replacing it with

BaO).

5. **A POSA would not have selected Miwa '535's Embodiment 15 as a starting point for a glass composition where the SrO and BaO amounts could be modified to create an improved glass.**

59. Dr. Ernst does not explain why a POSA would have selected Miwa '535's Embodiment 15 as a starting point for his analysis. In fact, when looking at Miwa '535's 20 embodiments, there is no readily identifiable reason for why a POSA would have cherry-picked Embodiment 15 for modification. Table 1 below shows measured glass properties reported by Miwa '535 for each of Miwa '535's 20 embodiments. In the context of Miwa '535's disclosure, values highlighted green mean the glass property is better than Embodiment 15. Values highlighted red mean the glass property is worse than Embodiment 15. And values highlighted yellow indicate the value is the same as that reported for Embodiment 15.

Em.	Transmittance (%)				Density (g/cm ³)	CTE (10 ⁻⁷ °C ⁻¹)	Strain Point (°C)	Log 10 ^{2.5} (°C)	Liquidus Temperature (°C)
	300 nm	400 nm	600 nm	800 nm					
1	74	92	92	92	2.38	32	675	1610	1095
2	71	91	91	92	2.38	32	675	1610	1095
3	69	91	91	92	2.38	32	675	1610	1095
4	66	91	91	92	2.38	32	675	1610	1095
5	60	90	90	91	2.4	33	674	1595	1105
6	55	90	91	91	2.4	33	676	1595	1105
7	72	91	92	92	2.35	31	670	1590	1080
8	61	91	91	92	2.35	31	668	1590	1080
9	63	91	91	92	2.35	31	671	1595	1080
10	67	91	92	92	2.37	32	670	1600	1110
11	65	91	92	92	2.4	34	665	1555	1105
12	72	91	92	92	2.44	33	671	1560	1055
13	70	91	92	92	2.35	31	668	1605	1090
14	74	92	92	92	2.4	33	669	1565	1085
15	70	91	92	92	2.39	34	673	1560	1120
16	72	91	92	92	2.42	34	677	1585	1095
17	71	91	92	92	2.43	34	680	1520	1115
18	71	91	92	92	2.4	33	682	1585	1100
19	66	91	91	92	2.43	31	686	1560	1115
20	65	91	91	92	2.41	30	685	1605	1045

60. As shown in Table 1, Embodiment 15 displays the highest liquidus temperature, performing the worst out of every single embodiment displayed in Miwa '535. Miwa '535 teaches that “[increased] liquid phase temperature ... mak[es] the glass difficult to mold.” EX1004, ¶25. The table above also shows that Embodiment 15 has a CTE of $34 \times 10^{-7} \text{ }^{\circ}\text{C}^{-1}$, which is tied for worst out of all of Miwa '535's embodiments. Miwa '535 teaches that “coefficient of thermal expansion must be small in order to improve thermal shock resistance and reduce damage during the heat treatment process.” EX1004, ¶5.

61. Without some evidence to support otherwise, there is no reason why a POSA would have chosen Miwa's worst-performing embodiment in terms of liquidus temperature and CTE for a potential modification that would create a composition as claimed in the '491 patent. Dr. Ernst does not address how or why a POSA would have balanced each of the performance metrics list for each embodiment, or why a POSA would have looked past the poor liquidus temperature and CTE properties of Embodiment 15 when attempting to modify that embodiment. As discussed above, the literature would have taught a POSA that Dr. Ernst's proposed modification (i.e., reduce the amount of BaO and replace it with SrO) could have caused Embodiment 15 to perform even worse in terms of liquidus temperature and CTE.

B. The Petition and Dr. Ernst fail to show that a POSA would have modified Miwa '535 to arrive at the glass of claim 13.

62. The Petition only relies on Miwa '535's disclosure to allegedly show the obviousness of claim 13: "*all* of the limitations of Claim 13 are described by Miwa '535" (emphasis added). Pet., 36. Conflictingly, Dr. Ernst appears to propose modifying Miwa '535 Embodiment 15 twice to arrive at the glass of claim 13.

63. Dr. Ernst first modifies Miwa '535 Embodiment 15 by substituting BaO with SrO. EX1003, ¶190. This modification is not explained in the Petition. It has to be *inferred* by comparing the table presented in EX1003, ¶184 (describing

Miwa '535 as having 0.63 mol% SrO and 0.21 mol% BaO) with the table presented in EX1003, ¶193 (describing the proposed glass modified in view of JP '741 as having 0.93 or 0.94 mol% SrO and 0 mol% BaO). To the extent that Dr. Ernst and the Petition rely on substituting all the BaO with SrO in Miwa '535's Embodiment 15 for claim 13, I refer to my discussion above as to why a POSA would not have been motivated to make this substitution in Miwa '535.

64. Dr. Ernst also proposes modifying the fining agents used in Miwa '535's Embodiment 15 by removing all of the Sb_2O_3 and SnO_2 in Embodiment 15, and adding back in SnO_2 . EX1003, ¶¶190-195. Assuming Dr. Ernst and the Petition intended to substitute Sb_2O_3 for SnO_2 in Miwa '535's Embodiment 15, a POSA would not have been motivated to make such a substitution.

65. As calculated by Dr. Ernst, Miwa '535's Embodiment 15 contains 0.02 mol% Sb_2O_3 . EX1003, ¶53. Dr. Ernst and the Petition appear to propose adding between 0.02 and 0.85 mol% SnO_2 to the composition to replace the fining agent Sb_2O_3 . EX1003, ¶193. But there is no teaching in either of JP '741 or Peuchert '469 that discusses the replacement of Sb_2O_3 with SnO_2 . Rather, JP '741 discusses the replacement of As_2O_3 with SnO_2 . EX1005, Abstract, ¶¶4-7. Peuchert '469 is similarly silent on substituting Sb_2O_3 for SnO_2 .

66. Sb_2O_3 was known to behave differently compared to SnO_2 as a fining agent. A POSA would not have viewed these oxides as simply interchangeable.

For example, Shelby (EX2017) teaches that “[a]rsenic and antimony oxides are the most efficient and thoroughly studied chemical fining agents.” EX2017, 43. A POSA would have understood that other less toxic fining agents, such as SnO_2 , “are usually less efficient ... approaches to chemical fining.” EX2017, 44.

Accordingly, a POSA would not have been motivated to replace Sb_2O_3 with the inferior fining agent SnO_2 in view of JP '741 and/or Peuchert '469. The Petition and Dr. Ernst also fail to show any evidence that a POSA would have had a reasonable expectation of success in modifying the glass compositions of Miwa '535 in the way that they suggest.

VIII. CLAIMS 1 AND 13 WOULD NOT HAVE BEEN OBVIOUS IN VIEW OF JP '643, JP '741, AND PEUCHERT '469.

67. The Petition and Dr. Ernst rely on the primary reference of JP '643 for obviousness of claims 1 and 13 in Ground 2. Pet., 41. The Petition and Dr. Ernst acknowledge that the glass composition used for Ground 2 (JP '643 Sample 5) does not meet the BaO and/or the Sb_2O_3 mole percentages recited in claims 1 and 13. Pet, 43 (showing Sample 5 having 0.2 mol% BaO and 0.2 mol% Sb_2O_3). To address the BaO mol%, the Petition and Dr. Ernst propose substituting BaO with SrO in JP '643's Sample 5, similar to the substitution in Miwa '535's Embodiment 15 in Ground 1. Pet. 44-45, EX1003, ¶¶258-263. And to address the Sb_2O_3 mol%, the Petition and Dr. Ernst propose modifying the fining agents used in JP '643 in

view of JP '741, again, similar to Ground 1. Pet., 46, EX1003, ¶¶266-273.

Essentially, the Petition and Dr. Ernst re-hash the arguments and art from Ground 1 in Ground 2, except they start with JP '643's Sample 5 instead of Miwa '535's Embodiment 15.

68. I disagree that a POSA would have found it obvious to modify JP '643 to remove all of the BaO for SrO as described by the Petition and Dr. Ernst to arrive at the glass of claim 1 with a reasonable expectation of success. I also disagree that JP '741 would have motivated a person to substitute Sb_2O_3 for SnO_2 in JP '643's Sample 5 with a reasonable expectation of success.

A. A POSA would not have been motivated to completely substitute BaO for SrO in JP '643's Sample 5.

69. Similar to my discussion above in Section VII.A, a POSA would not have been motivated to substitute BaO for SrO in JP 643's Sample 5 based on the ionic field strengths of Ba^{2+} and Sr^{2+} cations. Dr. Ernst's proposition in this regard is overly simplistic, and a POSA would have known that such a modification could lead to unpredictable—and potentially detrimental—results on the properties of a resultant glass in JP '643. Further, just as in Ground 1, the Petition and Dr. Ernst attempt to cite Peuchert '469 as an alleged teaching as to the interchangeability of these two metal oxides. But, just as in Ground 1, the Petition and Dr. Ernst fail to point to any actual teaching of Peuchert '469 to suggest substitution BaO with SrO,

much less with any reasonable expectation of success.

70. JP '643 clearly values the presence of BaO in its glass compositions. Every single one of the 46 glass compositions disclosed by JP '643 contain BaO—not a single composition contains 0 mol% BaO. EX1007, ¶¶[0054]-[0069]. Further, JP '643 touts the benefits of BaO, disclosing that

“when reducing BaO and SrO to achieve lower density, if the *contents of these two components become extremely imbalanced*, the effect of improving BHF resistance diminishes. Thus, it is desirable to *include both components* such that the mass ratio (BaO+SrO)/BaO satisfies the range of 1.1–10 (preferably 1.2–5). The *preferred BaO content is 0.3% or more (more preferably 0.5% or more)* and 2% or less (more preferably 1% or less), and the preferred SrO content is 0.1–2.7%, more preferably 0.3–1.5%.” EX1007, ¶39 (emphasis added).

71. Put another way, JP '643 itself discloses a preference for “both components” BaO and SrO, and specifically highlights a BaO content of “0.3% or more[.]” EX1007, ¶39. The Petition and Dr. Ernst’s proposed modification flies in the face of JP '643’s disclosure, preventing both components from being present in the composition, and ignoring the preferred BaO content of at least 0.3%. In fact, the proposed modification is the most imbalanced ratio of these two components, with an infinite ratio of strontium oxide to barium oxide. JP '643 teaches that such

an imbalanced ratio of BaO to SrO is detrimental at least because it reduces the buffered hydrofluoric acid [BHF] resistance of a glass composition. EX1007, ¶¶39-40.

72. Like in Ground 1, the Petition and Dr. Ernst further attempt to bolster their argument by citing Peuchert '469 in Ground 2. Pet. 44-45, EX1003, ¶¶260-261. According to the Petition and Dr. Ernst, Peuchert '469's disclosure of glass compositions with the "sum of the two heavy alkaline earth metal oxides SrO and BaO [being] preferably limited to a maximum of 4% by weight" would have helped motivate a POSA to change the mol% of BaO in JP '643's Sample 5. Pet. 44-45, EX1003, ¶¶260-261. Aside from citing Peuchert '469 as disclosing a maximum wt% of SrO and BaO, the Petition and Dr. Ernst provide no actual reason for why Peuchert '469 would have motivated a POSA to modify JP '643's Sample 5 at all, much less with a reasonable expectation of success. Peuchert '469 does not disclose or suggest substituting BaO with SrO, much less does Peuchert '469 disclose any interplay between these two oxides.

73. Further, the glasses disclosed in Peuchert '469 are based on the MgO-Al₂O₃-SiO₂ (MAS) system, diluted by small amounts of B₂O₃ and modified by CaO, which is a significantly different base composition of glasses than that described in JP '643. For example, the minimum MgO concentration in Peuchert's examples is 8.1 wt% and the maximum B₂O₃ concentration is 6.5 wt%. EX1006, 4

(Table). These weight percentages are distinctly different from those described in JP '643. The range of MgO and B₂O₃ in JP '643's non-comparative samples 1-46 are 0-1.0 wt% and 9.4-12.0 wt%, respectively. EX1007, ¶¶54-69. Because these compositions are so different, a POSA would not have considered Peuchert '469 for motivation to modify the BaO and/or SrO mole percentages in JP '643.

74. In light of these teachings, a POSA would not have been motivated to make the change proposed by the Petition and Dr. Ernst. The Petition and Dr. Ernst fail to provide any reason for why a POSA would have wanted to go against the express teachings of JP '643, and thus fail to show the obviousness of their proposed modification, much less do they establish a reasonable expectation of success in modifying JP '643 as proposed.

B. A POSA would not have been motivated to substitute Sb₂O₃ for SnO₂ in JP '643's Sample 5.

75. In modifying JP '643 to address limitations 1[i]-[l], the Petition and Dr. Ernst argue that a POSA would have been motivated to reduce the 0.2 mol% of Sb₂O₃ in Sample 5 to 0 mol%, EX1003, ¶270 (describing “[r]emov[ing] the mass fraction $W_{\text{Sb}_2\text{O}_3} = 1 \text{ ms}\% = 0.01$ of Sb₂O₃”). To account for the reduction of Sb₂O₃, the Petition and Dr. Ernst argue that a POSA would have found it obvious to add additional SnO₂ to the composition of Sample 5. Pet., 46, EX1003, ¶271.

76. Petitioner and Dr. Ernst base this argument on JP '741's disclosure of

glass compositions that use SnO_2 as a fining agent. Pet., 46, EX1003, ¶268. But JP '741 is entirely silent on replacing Sb_2O_3 with SnO_2 as a fining agent. Rather, JP '741 explains that “it is an object of the present invention to provide an alkali-free glass that ***does not use As_2O_3*** as a clarifying agent and does not contain bubbles that cause display defects.” EX1005, ¶[0006] (emphasis added). JP '741 does not discuss Sb_2O_3 at all.

77. JP '741 also does not disclose that SnO_2 is a suitable substitute for Sb_2O_3 in a glass composition like that of JP '643's Sample 5. And Dr. Ernst provides no evidence to substantiate the idea that SnO_2 could be successfully substituted for Sb_2O_3 in Sample 5 at all, much less with a reasonable expectation of success.

78. In place of substantiating the argument, Dr. Ernst suggests that JP '643 and JP '741 can be combined because “the composition of Sample 5 in JP '643 falls within the compositional range described in JP '741, making it applicable to use the same types and contents of fining agents.” EX1003, ¶268. But this statement is not actually true at least because Sample 5 in JP '643 contains ZrO_2 . EX1007, ¶[0055]. The compositional ranges in JP '741 do not include a range for ZrO_2 specifically. *See, e.g.*, EX1005, ¶[0022].

79. The Petition and Dr. Ernst do not even attempt to establish a reasonable expectation of success for modifying JP '643 in view of JP '741. A

POSA would have understood that SnO_2 was a less effective fining agent than Sb_2O_3 , and therefore would not have reasonably expected that as little as 0.02 mol% SnO_2 (*see* EX1003, ¶271) would replace the loss of 0.2 mol% Sb_2O_3 fining agent. For example, Shelby (EX2017) teaches that “[a]rsenic and antimony oxides are the most efficient and thoroughly studied chemical fining agents.” EX2017, 43. A POSA would have understood that other less toxic fining agents, such as SnO_2 , “are usually less efficient ... approaches to chemical fining.” EX2017, 44. Accordingly, a POSA would not have been motivated to replace Sb_2O_3 with the inferior fining agent SnO_2 in view of JP ’741. Indeed, there are 43 examples in JP ’643 that use Sb_2O_3 as a fining agent, with 40 of them using at least 0.2 mol% Sb_2O_3 . EX1007, ¶¶[0054]-[0069]. The Petition and Dr. Ernst fail to show any evidence that a POSA would have had a reasonable expectation of success in modifying the glass compositions of JP ’643 in the way that they suggest.

C. The Petition and Dr. Ernst cannot assume, without evidence, that the liquidus viscosity of JP ’643’s Sample 5 would remain unchanged after their proposed modifications.

80. As discussed, the Petition and Dr. Ernst argue it would have been obvious to modify both the BaO and Sb_2O_3 mole percentages in JP ’643’s Sample 5 in view of Peuchert ’469 and JP ’741, respectively. That said, when addressing the liquidus viscosity recited in claim 1, the Petition and Dr. Ernst cite to the original composition of JP ’643’s Sample 5. Pet., 46, EX1003, ¶275 (“Sample 5 of

JP '643 reports a liquidus viscosity of $10^{5.4}$ dPa·s (250,000±60,000 P"). However, the Petition and Dr. Ernst modified Sample 5 of JP '643 twice in an attempt to show obviousness. Neither the Petition nor Dr. Ernst claim that the twice-modified composition of JP '643's Sample 5 meets the liquidus viscosity limitation of claim 1. As Dr. Ernst repeatedly asserted in a related IPR proceeding, "[t]he liquidus viscosity of a glass is a direct consequence of the glass composition." *See* IPR2025-00937, EX1003, ¶¶158, 197, 276. By modifying the glass composition of JP '643's Sample 5, Dr. Ernst admits that the liquidus viscosity of the given glass must change, as a "direct result" of its modified composition.

81. Indeed, Kim (EX2009) teaches that "the viscosity and the liquidus temperature show a continuous decrease with increase of BaO [with respect to SrO]" for a plasma display panel glass composition. EX2009, 164. And Kim shows that the ratio of BaO to SrO can have non-linear effects on the liquidus temperature, which do not necessarily follow a predictable pattern. Kim's data reported in Figure 3 (reproduced below) shows that varying the ratio of BaO to BaO+SrO between 0 and 1 creates a non-linear effect on liquidus viscosity. EX2009, 162. The Petition and Dr. Ernst do not discuss any particular relationship between a glass composition and its liquidus viscosity, much less do they address the potential changes in this property based on glass composition. The Petition and

Dr. Ernst's assumption that modifying the BaO/SrO ratio of a glass composition will not affect the liquidus viscosity of a glass composition is unfounded.

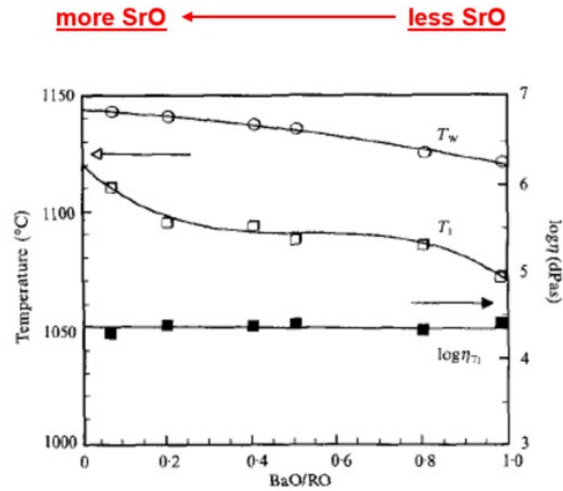


Figure 3. Liquidus temperatures (T_l), working temperature (T_w) and viscosity at liquidus temperature ($\log \eta_l$) as a function of BaO/RO

EX2009, 162, FIG. 3 (annotated).

82. The Petition and Dr. Ernst fail to provide any evidence that this twice-modified composition displays the claimed liquidus viscosity of claim 1.

D. The Petition and Dr. Ernst fail to show obviousness of claim 13.

83. The Petition and Dr. Ernst acknowledge that the mol% for Sb_2O_3 in JP '643's Sample 5 exceeds the claimed maximum value of 0.005 mol%. Pet. 53; EX1003, ¶¶ 322-327. In an attempt to cure this deficiency in JP '643, Petitioner argues that it would have been obvious to "[r]emove the mass fraction $W_{\text{Sb}_2\text{O}_3} = 1 \text{ ms\%} = 0.01$ of Sb_2O_3 ," thus reducing the 0.2 mol% of Sb_2O_3 in Sample 5 to 0 mol%. Pet., 53, EX1003, ¶ 325. To account for the reduction of Sb_2O_3 , Petitioner

argues that a POSA would have found it obvious to add additional SnO_2 to the composition of Sample 5 in view of JP '741. Pet., 53, EX1003, ¶¶ 322-328.

84. I disagree. As I explained above in Section VIII.B, there is no teaching in JP '741 that suggests substituting Sb_2O_3 with SnO_2 , and a POSA would not have been motivated to make such a substitution in view of JP '741 with a reasonable expectation of success.

IX. THE PETITION AND DR. ERNST HAVE NOT ESTABLISHED THAT MIWA '377 EXPRESSLY OR INHERENTLY DISCLOSES THE CLAIMED LIQUIDUS VISCOSITY IN CLAIM 13.

85. Miwa '377, cited in Ground 3 of the Petition, does not disclose the liquidus viscosity limitation of claim 13. Miwa '377 does not expressly disclose the liquidus viscosity of any of its glasses. Further, the Petition and Dr. Ernst fail to establish that the claimed liquidus viscosity is an inherent feature of the cited glass composition in Miwa '377.

A. Miwa '377 does not expressly disclose a liquidus viscosity for any of its embodiments.

86. Miwa '377's disclosure does not include reported values for the liquidus viscosities of any of its embodiments, including Embodiment 8 cited by the Petition and Dr. Ernst. Miwa '377 only mentions the concept of liquidus viscosity once—in reference to some unidentified “prior art” in paragraph [0012]. Paragraph [0012] in Miwa '377 generally describes prior art characteristics of “[g]lass substrates [] widely used as flat display substrates for liquid crystal

displays, EL displays, and other devices.” EX1008, ¶[0002]. But this general discussion of the prior art is not specifically linked to any of Miwa ’377’s embodiments. Miwa ’377 never explicitly explains that its embodiments have a liquidus viscosity consistent with the prior art or specifies what such liquidus viscosities would necessarily be.

B. The Petition and Dr. Ernst do not show that a liquidus viscosity of greater than or equal to 100,000 poise is inherent to Miwa ’377’s Embodiment 8.

87. I have been informed by counsel that, for a prior art reference to inherently anticipate a patent claim, a Petitioner must provide conclusive proof that the reference necessarily discloses every limitation of the claimed invention. Here, Dr. Ernst and the Petition do not conclusively show that Miwa ’377’s Embodiment 8 necessarily has a liquidus viscosity of greater than or equal to 100,000 poise. In fact, neither the Petition nor Dr. Ernst present any evidence to show that Miwa ’377’s Embodiment 8 necessarily has a liquidus viscosity of greater than or equal to 100,000 poise.

X. CONCLUSION

88. In signing this declaration, I recognize that the declaration will be filed as evidence in an *inter partes* review before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required, I will appear for cross-examination within the United States during the time allotted.

89. 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.

Executed on this 16th day of September 2025, in Fort Worth, TX.



Dr. Richard Brow