

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GC Corporation and GC America, Inc.,

Petitioner

v.

Ardent, Inc.,

Patent Owner

CASE: Unassigned

Patent No. 6,455,451

PETITION FOR *INTER PARTES* REVIEW
UNDER 37 C.F.R. §42.100

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I. Introduction

Claims 1-4 and 57-61 (“the Challenged Claims”) of U.S. Patent No. 6,455,451 (“the ’451 patent,” Ex. 1002) are unpatentable and should be canceled. The ’451 patent is generally directed to lithium disilicate glass-ceramic compositions and methods for making them, including for use in dental restorations. However, the compositions and restorations claimed in the Challenged Claims were both known and obvious years before the application for the ’451 patent was filed.

As shown below, the Challenged Claims are unpatentable for numerous reasons. For instance, inventors at Corning Inc. patented, in 1993, lithium disilicate-containing glass-ceramics having compositions highly similar to those claimed in the ’451 patent, and further disclosed broad ranges overlapping those disclosed in the ’451 patent for each component. Ex. 1004 (“Beall”). One of the inventors named on this patent also separately published a paper disclosing similar lithium disilicate-containing glass-ceramics in 1991. Ex. 1005 (“Echeverria”). And, in 1995, an inventor Petticrew expressly disclosed molding dental restorations using lithium disilicate glass-ceramic compositions, specifically referencing Beall. Ex. 1003 (“Petticrew”).

Accordingly, for the reasons set forth in this Petition, the Challenged Claims are unpatentable in view of the prior art disclosures of the claimed compositions and

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dental restorations and should be canceled.

II. Grounds for Standing Pursuant to 37 C.F.R. §42.104(a)

Petitioner certifies that the '451 patent is available for IPR and that Petitioner is not barred or estopped from requesting IPR.

III. '451 Patent

A. Overview

The '451 patent relates to “lithium disilicate ($\text{Li}_2\text{Si}_2\text{O}_5$) based glass-ceramics” that “are useful in the fabrication of single and multi-unit dental restorations (e.g. anterior bridges).” Ex. 1002, Abstract; Ex. 1001 ¶18.

The '451 patent, however, acknowledges that there was nothing new about the use of lithium disilicate glass-ceramics in dental restorations and admits that U.S. Patent No. 4,189,325 to Barrett *et al.* discloses “dental restorations made from castable lithium disilicate glass-ceramics.” Ex. 1002 at 1:21-31¹; Ex. 1001 ¶19-21.²

¹ All citations to original page numbers except Ex. 1006.

² Patent Owner is bound by applicants' admissions regarding the prior art. *PharmaStem Therapeutics, Inc. v. ViaCell, Inc.*, 491 F.3d 1342, 1362 (Fed. Cir. 2007); *Constant v. Advanced Micro-Devices, Inc.*, 848 F.2d 1560, 1570 (Fed. Cir. 1988); *Corning Glass Works v. Brenner*, 470 F.2d 410, 419 (D.C. Cir. 1972) (finding

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B. Claims

The claims of the '451 patent are directed to glass-ceramic compositions and dental restorations (claims 1-16 and 57-65) and to methods of making a lithium disilicate dental restoration or product (claims 17-56 and 66). This petition relates to certain glass-ceramic composition and dental restoration product claims, but not the method claims. Ex. 1001 ¶22.

Independent claims 1, 3 and 57 recite a glass-ceramic composition (claim 1, 3) and a dental restoration comprising a glass-ceramic (claim 57) “consisting essentially of” several components. The component limitations in claims 1, 3 and 57 fall into one of two categories: (1) components that must be present in a certain weight percentage range and (2) components that need not be present but have an upper weight limit, also expressed as a percentage. Limitations according to the first category recite “about X% to about Y%” of a particular component, whereas limitations according to the second category recite “up to about X%” of a particular component. Independent claim 61 recites a dental restoration comprising the glass-

“admission of prior art in their application and subsequent briefs may not be denied by their submission of an affidavit under Rule 1.131 . . . purporting to place their own invention prior to that of [the admitted prior art]”).

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ceramic composition comprising several components that must be present in a particular percentage range (the first category described above).

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<u><i>Claim 1</i></u>	<u><i>Claim 3</i></u>	<u><i>Claim 57</i></u>	<u><i>Claim 61</i></u>
about 64 to about 70% SiO ₂	about 64 to about 70% SiO ₂	about 62 to about 85% SiO ₂ ;	about 64 to about 70% SiO ₂
about 1.5 to about 6 Al ₂ O ₃	about 5.2 to about 9 Al ₂ O ₃	about 1.5 to about 10% Al ₂ O ₃ ;	about 5.2 to about 9 Al ₂ O ₃
about 10 to about 15% Li ₂ O	about 10 to about 15% Li ₂ O	about 8 to about 19% Li ₂ O;	about 10 to about 15% Li ₂ O
about 2.5 to about 5% K ₂ O	about 2 to about 7% P ₂ O ₅	about 2.5 to about 7% K ₂ O;	about 2 to about 7% P ₂ O ₅
about 2 to about 7% P ₂ O ₅	up to about 1.5% F	about 0.5 to about 12% P ₂ O ₅	
up to about 1.5% F	up to about 7% BaO	up to about 4.9% B ₂ O ₃ ;	
up to about 7% BaO	up to about 1% SrO	up to about 1.5% F;	
up to about 1% SrO	up to about 5% Cs ₂ O	up to about 7% CaO;	
up to about 5% Cs ₂ O	up to about 5% K ₂ O	up to about 7% BaO;	

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up to about 2.7% B_2O_3	up to about 2.7% B_2O_3	up to about 1% SrO;	
up to about 0.9% CaO	up to about 0.9% CaO	up to about 5% Cs_2O ;	
up to about 3% Na_2O	up to about 3% Na_2O	up to about 5% Na_2O ;	
up to about 2% TiO_2	up to about 2% TiO_2	up to about 2% TiO_2 ;	
up to about 3% ZrO_2	up to about 3% ZrO_2	up to about 3% ZrO_2 ;	
up to about 1% SnO_2	up to about 1% SnO_2	up to about 1% SnO_2 ;	
up to about 1% Sb_2O_3	up to about 1% Sb_2O_3	up to about 1% Sb_2O_3 ;	
up to about 3% Y_2O_3	up to about 3% Y_2O_3	up to about 3% Y_2O_3 ;	
up to about 1% CeO_2	up to about 1% CeO_2	up to about 1% CeO_2 ;	

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up to about 1% Eu ₂ O ₃	up to about 1% Eu ₂ O ₃	up to about 1% Eu ₂ O ₃ ;	
up to about 1% Tb ₄ O ₇	up to about 1% Tb ₄ O ₇	up to about 1% Tb ₄ O ₇ ;	
up to about 2% Nb ₂ O ₅	up to about 2% Nb ₂ O ₅	up to about 2% Nb ₂ O ₅ ; and	
up to about 2% Ta ₂ O ₅	up to about 2% Ta ₂ O ₅	up to about 2% Ta ₂ O ₅ .	

Ex. 1001 ¶23. The challenged dependent claims add further limitations generally set forth below:

<i>Claim</i>	<i>Limitations</i>
2 and 4	“glass-ceramic is pressable”
3	further defining composition ranges
58	defining various components into which the dental restorations may be formed
59	directed to a “blank for machining the dental restoration”

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<i>Claim</i>	<i>Limitations</i>
60	directed to a “dental restoration comprising the glass-ceramic of claim 1”

C. Prosecution History

The '451 Patent issued on September 24, 2002 from Application No. 09/458,919 (“the '919 application”), filed December 10, 1999, which claims priority to three provisional applications filed between December 11, 1998 and September 14, 1999. Ex. 1002, cover, Ex. 1001 ¶24.

The Patent Office rejected as-filed claims 1-3 and 48-50 under 35 U.S.C. § 102(b) as being anticipated by Goto *et al.* (US 5,391,522; “Goto”). Ex. 1006, 58-59. The Examiner found that Examples 1, 3, 6, 8, and the comparison example of Goto teach compositions which fall within the claimed ranges. *Id.*, 59. The Examiner also found that the presence of PbO in Goto’s compositions is not excluded because of the use of “comprising.” *Id.*

As-filed claims 1-3, 43-45, 48-50, and 53-55 were also rejected under 35 U.S.C. § 103(a) as being unpatentable over Goto. *Id.* The Examiner asserted that Goto suggested the claimed glass- ceramics because the glass-ceramic composition taught in Goto overlapped with the claimed glass-ceramic composition and Goto

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taught that the presence of alumina was desirable to improve the chemical durability of the glass-ceramic. *Id.* The Examiner also asserted that, because Goto's composition overlapped with the claimed composition, the glasses taught in Goto must inherently be pressable. *Id.*

As-filed claims 48-51 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,507,981 to Petticrew ("Petticrew '981"). *Id.*, 59-60. The Examiner found that the glass-ceramic compositions taught in Petticrew '981, particularly those disclosed in column 9 and table II of Petticrew '981, overlapped with the claimed glass-ceramic compositions. *Id.*, 60.

As-filed claims 1, 2, 4, 23, 24, 43, 44, and 46 were also rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 5,968,856 to Schweiger *et al.* ("Schweiger '856"). *Id.* As-filed claims 1-4, 23, 24, 43-46, and 58-61 were additionally rejected under 35 U.S.C. § 103(a) as being unpatentable over Schweiger '856. *Id.*, 60-61, Ex. 1001 ¶25.

On April 23, 2001, the applicant filed a response to the non-final Office Action cancelling claims 3, 9, 28, and 48-51. Ex. 1006, 73. The rejected independent claims, including as-filed claims 43 and 53, were amended to recite "consisting essentially of" instead of "comprising" and add "up to about X% of Y" as appears in the issued claims. *Id.*, 73-76. In the remarks, applicants stated that:

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The claimed invention is now directed to a glass-ceramic composition *consisting essentially of* SiO₂; Al₂O₃; Li₂O; K₂O; and P₂O as main ingredients in the composition. The following components may also be present; B₂O₃; F; CaO; BaO; SrO; Cs₂O; Na₂O; TiO₂; ZrO₂; SnO₂; Sb₂O₃; Y₂O₃; CeO₂; Eu₂O₃; Tb₄O₇; Nb₂O₅; and Ta₂O₅.

Id., 80³ Although applicants adopted a definition of “consisting essentially of” in which only the recited components are permitted, this definition is not material because the prior art renders unpatentable the Challenged Claims even under this narrower interpretation. Regarding Goto and Schweiger ’856, applicants stated that:

There is [no] mention of MgO or ZnO in the claimed composition. Goto ’522 requires the presence of MgO and ZnO in an amount of at least 0.5%. The claimed invention is not anticipated or rendered obvious over Goto ’522

Schweiger ’856 requires the presence of La₂O₃ in an amount of at least 0.1 percent. As set forth in Schweiger ’856, La₂O₃ and Al₂O₃ are required in the composition to provide a free-flowing glass ceramic that can be pressed in the plastic state. The claimed invention excludes the presence of La₂O₃. Moreover, the present invention excludes the presence of MgO and ZnO which may be present in the Schweiger ’856

³ All emphases added unless otherwise indicated.

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composition. The claims are not anticipated or rendered obvious by the Schweiger '856 reference.

Id., 80-81.

Applicants differentiated the amended claims from Goto by referring to the fact that MgO and ZnO were not mentioned in the claim or in the list of additional compounds covered by “consisting essentially of.” *Id.*, 80. Applicants similarly differentiated the amended claims from Schweiger '856 by indicating that the claimed composition excluded the presence of La₂O₃, which is not recited in the claim or in the list of additional compounds covered by “consisting essentially of.” *Id.*, 80-81, Ex. 1001 ¶26-27.

On May 31, 2001, the Patent Office issued a Notice of Allowability allowing as-filed claims 1, 2, 4-8, 10-27, 29-47, and 52-77. Ex. 1006, 92. , Ex. 1001 ¶28. Instead of paying the required issue fee, however, applicants filed a Continued Prosecution Application, or so-called CPA, on August 16, 2001, together with an Information Disclosure Statement. *Id.*, 101-116, Ex. 1001 ¶29.

On October 25, 2001, the Patent Office issued another non-final Office Action. Ex. 1006, 117-123. Ex. 1001 ¶30. In that Office Action, the Examiner rejected previously allowed as-filed claims 1, 2, and 24 under 35 U.S.C. § 102(b) as being anticipated by a number of references—Borom *et al.*; GB 1,312,700; EP

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536,479; DE 2,451,121 or US 3,816,704. Ex. 1006, 120-121. As-filed claims 1 and 2 were also rejected under U.S.C. § 102(b) as being anticipated by JP 1-145,348. *Id.*, 121. The Examiner asserted that each of the cited references taught glass-ceramic compositions that fell within the claimed composition and would be inherently pressable. *Id.*, 120-121.

On January 31, 2002, applicants filed a response to the non-final Office Action, cancelling as-filed claims 1 and 2 and amending as-filed claim 24 to recite “a blank for machining the dental restoration of claim 4.” *Id.*, 129-130. Applicants argued that the term “blank” is a term of art used to describe the block material used in computer-assisted design/computer-assisted milling (CAD/CAM) operations and none of the cited references showed or suggested a blank or block of glass-ceramic material for machining into a dental restoration. *Id.*, 132.

On March 13, 2002, the Patent Office issued a second Notice of Allowability allowing all the then-pending claims. *Id.*, 143. The ’919 application was then issued as the ’451 Patent on September 24, 2002. *Id.*, 148-161.

IV. Identification of Challenge Pursuant to 37 C.F.R. §42.104(b)

A. 37 C.F.R. §42.104(b)(1): Claims for Which IPR Is Requested

IPR is requested for claims 1-4 and 57-61. The undersigned authorizes the Office to charge any additional fees that may be due in connection with this Petition to Deposit Account 070181.

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B. 37 C.F.R. §42.104(b)(2): The Prior Art and Specific Grounds on Which the Challenge to the Claims Is Based

The references below are prior art to the '451 patent under pre-AIA 35 U.S.C. §§102 and 103. The one-year time bar under §102(b) is measured from the '451 patent's effective U.S. filing date, which at best is December 11, 1998.

Petitioner asks that the Board find claims 1-4 and 57-61 of the '451 patent unpatentable under 35 U.S.C. § 103, based on the following grounds:

	<i>References</i>	<i>Claims</i>	<i>Basis</i>
1	Beall	1 and 3	§103
2	Petticrew + Beall	2, 4, and 57-61	§103
3	Echeverria	3	§103
4	Petticrew + Echeverria	4, 57-59, and 61	§103

1. Petticrew

International App. Pub. No. WO 95/32678 ("Petticrew"), entitled "Method for Molding Dental Restorations and Related Apparatus," published December 7, 1995. Ex. 1003, cover. It qualifies as prior art under 35 U.S.C. §102(b). Petticrew is related to Petticrew '981 that was relied upon by the Examiner for rejections of under §103 during prosecution of the '451 patent. Ex. 1006, 59-60, Ex. 1001 ¶¶44-49.

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2. Beall

U.S. Patent No. 5,219,799 (“Beall”), entitled “Lithium Disilicate-Containing Glass-Ceramics Some of Which Are Self-Glazing,” issued on June 15, 1993. Ex. 1004, 1. It qualifies as prior art under 35 U.S.C. §102(b). Beall was cited to the Patent Office during prosecution of the ’451 patent (amongst 30 references) but not relied upon by the Examiner. Ex. 1002, 1-3; Ex. 1006, 65, Ex. 1001 ¶¶50-53.

3. Echeverria

In 1992— approximately seven years prior to the filing date of the ’919 application—Dr. Lina Echeverria of Corning Inc. published an article entitled “New Lithium Disilicate-Glass Ceramics” (“Echeverria”) in *Boletín de la Sociedad Española de Cerámica y Vidrio*, i.e., the *Journal of the Spanish Ceramic and Glass Society*. Ex. 1005; Ex. 1001 ¶¶54-55. It qualifies as prior art under 35 U.S.C. §102(b). Echeverria was not cited to the Patent Office during prosecution of the ’451 patent. Ex. 1002, 1-3; Ex. 1006.

C. 37 C.F.R. §42.104(b)(3): Claim Construction

Claims are to be given their “broadest reasonable construction in light of the specification.” 37 C.F.R. §42.100(b). The constructions proposed below are intended to aid in this proceeding, and should not be understood as waiving any arguments for litigation. Because the standard in an IPR is different from that used in District Court or in a Section 337 investigation, *Cuozzo Speed Tech., LLC v. Lee*,

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136 S.Ct. 2131, 2142 (2016); *In re Am. Acad. of Sci. Tech Ctr.*, 367 F.3d 1359, 1364, 1369 (Fed. Cir. 2004); MPEP §2111, Petitioner expressly reserves the right to argue different constructions there.

For this proceeding only, without conceding their correctness for litigation or in a Section 337 investigation, Petitioner proposes the following:

1. Consisting Essentially Of

The definition of “consisting essentially of” in the context of the ’451 patent is “consisting of SiO₂, Al₂O₃, Li₂O, K₂O and P₂O₅ as main ingredients with the following components also permitted—B₂O₃, F, CaO, BaO, SrO, Cs₂O, Na₂O, TiO₂, ZrO₂, SnO₂, Sb₂O₃, Y₂O₃, CeO₂, Eu₂O₃, Tb₄O₇, Nb₂O₅ and Ta₂O₅.” Ex. 1001 ¶34-35.

This definition comes directly from the prosecution history. During prosecution, the claims were amended to recite “consisting essentially of” in response to a specific rejection by the Examiner. In the remarks, applicants stated:

The claimed invention is now directed to a glass-ceramic composition ***consisting essentially of*** SiO₂; Al₂O₃; Li₂O; K₂O; and P₂O as main ingredients in the composition. The following components may also be present; B₂O₃; F; CaO; BaO; SrO; Cs₂O; Na₂O; TiO₂; ZrO₂; SnO₂; Sb₂O₃; Y₂O₃; CeO₂; Eu₂O₃; Tb₄O₇; Nb₂O₅; and Ta₂O₅.

Ex. 1006, 80.

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2. Dental Restoration

The term “dental restoration” should be construed as “a dental appliance shaped for placement into a patient’s mouth.” Ex. 1001 ¶36.

The authority supporting this definition is drawn from the intrinsic record. For example, the Abstract of the ’451 patent reads “[t]he glass-ceramics are useful in the fabrication of single and multi-unit dental restorations (e.g. anterior bridges) made by heat pressing into refractory investment molds produced using lost wax techniques.” Ex. 1002, Abstract; Ex. 1001 ¶37. And then later in the Abstract, it says, “[t]he resulting glass ceramics are then pulverized into powder and used to form pressable pellets and/or blanks of desired shapes, sizes and structures which are later pressed into dental restorations.” Ex. 1002, Abstract.

Additionally, there are numerous instances in the specification supporting Petitioner’s construction, e.g., “[t]he glass-ceramics are useful in the fabrication of single and multi-unit **dental restorations** including but not limited to orthodontic appliances, bridges, space maintainers, tooth replacement appliances, splints, crowns, partial crowns, dentures . . .” (*Id.*, 2:36-44), “Moreover, it is possible that the blanks may be machined to a **dental restoration** of desired geometry, ” (*Id.*, 3:17-18), and “Sintering imparts sufficient strength for handling of the pellets or blanks. These pellets and blanks may be used for pressing cores or other frameworks

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or shapes for dental restorations, (*Id.*, 5:62-65), to just highlight a few instances.

In light of the claim language and the numerous references to dental restorations in the specification, the term dental restoration should be construed as “a dental appliance shaped for placement into a patient’s mouth.”

3. Pressable

The word “pressable” should be construed as “able to be formed into dental articles by heat pressing or injection molding using commercially available equipment.” Ex. 1001 ¶38.

This definition is found in the specification of the ’451 Patent: “The glass-ceramics have good pressability, i.e., the ability to be formed into dental articles by heat pressing, also known as hot pressing, or injection molding, using commercially available equipment.” Ex. 1002, 2:44-48; Ex. 1001 ¶39.

4. Blank

The term “blank” should be construed as “a small piece of material in a form (such as a cylinder or rectangular block) suitable for further processing into a dental restoration.” Ex. 1001 ¶40; Ex. 1002, 3:4-9, 17-18.

5. About

The term “about” should be construed to mean “approximately.” Ex. 1001 ¶40. Patent Owner asserted in the Investigation that “approximately” should be further construed as ± 2 units in the least significant figure position. *See* Ex. 1009, 3;

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Ex. 1001 ¶42. In other words, for example, it argued that “about 1.5%” encompasses 1.3%-1.7% and “about 70%” encompasses 68%-72%. Ex. 1001 ¶59. The Challenged Claims are unpatentable under either construction. Ex. 1001 ¶43.

D. 37 C.F.R. §42.104(b)(4): How the Construed Claims are Unpatentable

An explanation of how claims 1-4 and 57-61 are unpatentable, including identification of how each claim feature is found in the prior art, is set forth below in Parts V-VII.

E. 37 C.F.R. §42.104(b)(5): Supporting Evidence

Petitioner’s Exhibit List supporting this Petition is attached. Exhibit 1001 is a Declaration of Dr. Arthur E. Clark under 37 C.F.R. §1.68 setting forth his qualifications in ¶¶1-10 and Exhibit A. The evidence’s relevance to the challenged claims, including an identification of the specific portions of the evidence supporting the challenge, is included in Parts V-IX.

V. Detailed Grounds for Unpatentability

The Challenged Claims are unpatentable as obvious in view of the asserted grounds in this Petition. A claim is unpatentable as obvious when “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

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pertains.” 35 U.S.C. §103(a); *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007).

Under §103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or nonobviousness of the subject matter is determined.

KSR, 550 U.S. at 406 (quoting *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966)).

A combination may be proven obvious, for example, by showing that it was obvious to try. *Id.* at 421. “The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.”

Id. at 416. “If a person of ordinary skill can implement a predictable variation, §103 likely bars its patentability.” *Id.* at 417. While evidence of secondary considerations of non-obviousness, if present, should be considered, it is not be accorded “substantial weight” unless a nexus between the evidence and the merits of the Challenged Claim is established. *Ormco Corp. v. Align Tech., Inc.*, 463 F.3d 1299, 1311-12 (Fed. Cir. 2006).

Regarding the ranges claimed in the patent compared to those disclosed in the prior art, a *prima facie* case of obviousness exists even where the claimed ranges or amounts do not overlap with the prior art but are merely close. *Titanium Metals Corp. of America v. Banner*, 778 F.2d 775, 783 (Fed.

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Cir. 1985) (claim directed to alloy of “having 0.8% nickel, 0.3% molybdenum, up to 0.1% iron, balance titanium” found obvious over reference disclosing alloys of 0.75% nickel, 0.25% molybdenum, balance titanium and 0.94% nickel, 0.31% molybdenum, balance titanium, because “[t]he proportions are so close that *prima facie* one skilled in the art would have expected them to have the same properties”). “[A] prior art reference that discloses a range encompassing a somewhat narrower claimed range is sufficient to establish a *prima facie* case of obviousness.” *In re Peterson*, 315 F.3d 1325, 1330 (Fed. Cir. 2003); *see also In re Harris*, 409 F.3d 1339 (Fed. Cir. 2005) (claimed alloy held obvious over prior art alloy that taught ranges of weight percentages overlapping, and in most instances completely encompassing, claimed ranges and narrower ranges taught by reference overlapped all but one range in claimed invention).

A person of ordinary skill in the art (POSITA), during the period from 1998-2002, would have had knowledge and experience relating to the design, production and use of glass-ceramic compositions for various applications. Such a person would have been able to design compositions for specific products, taking into account such variables as desired mechanical properties and the application for which the glass-ceramic composition is being used. The person of ordinary skill in the art would have had a bachelor’s or advanced degree, such as an M.S. or Ph.D. in

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chemistry, physics, ceramics, materials science and engineering, or chemical engineering, coupled with 2-5 years of academic or industry experience in the area of glass-ceramic research and development or similar work. Ex. 1001 ¶¶31-33.

Under Ground 1, claims 1 and 3 are unpatentable as obvious over Beall. The Examiner never considered claims 1 and 3 being obvious over Beall. Beall discloses broad ranges of lithium disilicate compositions, which are overlapping if not broader than the ranges disclosed in the 451 patent, and Beall's Examples are very close to the claimed compositions as well. Although Beall is not specifically directed to dental ceramics, claims 1 and 3 are not so limited.

Under Ground 2, claims 2, 4, and 57-61 are unpatentable as obvious based on the combination of Petticrew and Beall—a combination never considered by the USPTO. First, Petticrew discloses the use of lithium disilicate glass-ceramic materials for dental restorations, just as claimed and disclosed in the '451 patent. The Examiner found as-filed claims 48-51 obvious over Petticrew '981, and applicants cancelled those claims. The issued claims, however, are also obvious over the previously unconsidered combination of Petticrew and Beall. Second, Petticrew explicitly instructs a POSITA that Beall's compositions—which read on the recited compositional ranges in the '451 patent—are suitable as compositions for dental restorations. This strong case of obviousness, with Petticrew's explicit

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motivation to combine with Beall, cannot be overcome, even considering any purported secondary considerations Patent Owner may suggest.

Under Ground 3, claim 3 is unpatentable as obvious over Echeverria, a reference the Examiner never considered at all. Echeverria discloses examples of lithium disilicate compositions, which are even closer to the compositions disclosed in the '451 patent than those of Beall. Although Echeverria is not specifically directed to dental ceramics, claim 3 are not so limited.

Under Ground 4, claims 4, 57-59, and 61 are unpatentable based on the combined disclosure of Petticrew and Echeverria—another combination never considered by the USPTO. Dr. Lina Echeverria is a co-inventor of the Beall patent referenced above, and also worked at Corning at the same time as the inventor Beall. Dr. Echeverria separately published a paper discussing new lithium disilicate glass-ceramic materials suitable for a variety of applications. Given the similarity of Beall's and Echeverria's compositions, a POSITA would have realized that the compositions disclosed in Echeverria (just as those in Beall), read on the recited compositional ranges in the '451 patent, and are suitable as compositions for dental restorations.

VI. Ground 1 - Claims 1 and 3 Are Unpatentable Over Beall

Independent claims 1 and 3 of the '451 patent broadly recite “glass-ceramic

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composition[s]” that consist essentially of several components in various weight percentages. Ex. 1002, 11:49-12:8; 12:11-38; Ex. 1001 ¶56. The ranges disclosed in Beall render obvious the recited glass-ceramic compositions of claims 1 and 3. Ex. 1001 ¶56.

A. Claim 1

Claim 1 recites a “glass-ceramic consisting essentially of in weight percent” followed by a list of components set forth in the table below. As shown, the first five limitations recite components that must be present in amounts within the recited ranges. Ex. 1002, 11:49-12:8; Ex. 1001 ¶57. The remaining 17 limitations recite additional components that may optionally be present in amounts “up to about” a certain weight limit. Ex. 1002, 11:49-12:8; Ex. 1001 ¶57.

Beall discloses broad ranges for components that overlap the claimed ranges. Ex. 1004, 2:5-9; Ex. 1001 ¶58. Thus, Beall discloses compositions with ranges of components that would render obvious the composition recited in claim 1. Ex. 1001 ¶58.

The composition recited in claim 1 of the ’451 patent and the ranges of components disclosed in Beall are included in the table below. Ex. 1001 ¶59-61.

<i>’451 Patent Claim 1</i>	<i>Beall</i>
about 64 to about 70% SiO ₂	65-80%

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<i>'451 Patent Claim 1</i>	<i>Beall</i>
about 1.5 to about 6 Al ₂ O ₃	0-11%
about 10 to about 15% Li ₂ O	8-19%
about 2.5 to about 5% K ₂ O	0-7%
about 2 to about 7% P ₂ O ₅	1.5-7%
up to about 1.5% F	N/A
up to about 7% BaO	0-6%
up to about 1% SrO	0-6%
up to about 5% Cs ₂ O	N/A
up to about 2.7% B ₂ O ₃	N/A
up to about 0.9% CaO	0-10%
up to about 3% Na ₂ O	0-5%
up to about 2% TiO ₂	N/A
up to about 3% ZrO ₂	0-3%
up to about 1% SnO ₂	N/A
up to about 1% Sb ₂ O ₃	N/A

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<i>'451 Patent Claim 1</i>	<i>Beall</i>
up to about 3% Y ₂ O ₃	N/A
up to about 1% CeO ₂	N/A
up to about 1% Eu ₂ O ₃	N/A
up to about 1% Tb ₄ O ₇	N/A
up to about 2% Nb ₂ O ₅	N/A
up to about 2% Ta ₂ O ₅	N/A

The table above highlights the classic case of a prior art reference (Beall) disclosing ranges which at a minimum overlap the claimed range, if the claimed ranges are not entirely subsumed in the prior art ranges. For this reason, claim 1 is *prima facie* obvious. *Peterson*, 315 F.3d at 1330. There, the claimed composition was within each of the ranges disclosed in the prior art. *Id.* at 315 F.3d at 1329. “Selecting a narrow range from *within* a somewhat broader range disclosed in a prior art reference is no less obvious than identifying a range that simply *overlaps* a disclosed range.” *Id.* at 1329–30. The Court noted “the existence of overlapping or encompassing ranges shifts the burden to the applicant to show that his invention would not have been obvious.” *Id.* at 1330. In general, an applicant may overcome

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a *prima facie* case of obviousness by establishing “that the [claimed] range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range,” and “the applicant’s showing of unexpected results must be commensurate in scope with the claimed range.” *Id.* Here, there is no evidence establishing criticality of the claimed ranges. During prosecution, applicants canceled composition claims found to be anticipated and distinguished others, *e.g.*, MgO, ZnO and La₂O₃, on the basis that they are not recited in the claim or in the list of additional compounds covered by “consisting essentially of.” Ex. 1006, 80-81. There is nothing in the patent or prosecution history to suggest that the selected ranges of “about 64 to about 70% SiO₂,” “about 1.5 to about 6 Al₂O₃,” “about 10 to about 15% Li₂O,” “about 2.5 to about 5% K₂O,” and “about 2 to about 7% P₂O₅” lead to anything unexpected compared to the broader ranges disclosed in Beall.

With respect to the requirement associated with the “consisting essentially of” language of the preamble of claim 1, Beall does not include any unlisted components. The only component Beall identifies that is not recited in claim 1 is ZnO in an amount of 0-7%. Ex. 1004, 2:5-9. The disclosed range encompasses compositions having no ZnO. *Id.*; Ex. 1001 ¶62. Further, while the patentee argued “the present invention excludes the presence of MgO and ZnO” to distinguish over Schweiger (Ex. 1006 at 80-81), the ’451 patent actually claims compositions that *do*

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include up to about 5% ZnO. Ex. 1002, 13:10-53,15:31-56; Ex. 1001 ¶62.

Accordingly, Beall renders claim 1 unpatentable as obvious. Ex. 1001 ¶63.

B. Claim 3

Claim 3 recites a “glass-ceramic consisting essentially of in weight percent” followed by a list of several components set forth in the table below. As shown, four components must be present while the remaining limitations are optional. Ex. 1002, 12:11-38; Ex. 1001 ¶64. Claim 3 differs with respect to claim 1 in that the amount of Al₂O₃ has been changed to 5.2-9% and K₂O is now recited as an optional component up to about 5%. Ex. 1002, 11:49-12:8,12:11-38; Ex. 1001 ¶64.

Beall discloses broad ranges for the components that overlap the claimed ranges. Ex. 1004, 2:5-9; Ex. 1001 ¶65. Many of the claimed optional components in claim 3 are absent from Beall’s disclosed ranges. Ex. 1004, 2:5-9; Ex. 1001 ¶65. For those components that Beall identifies, the disclosed weight percentage ranges overlap those of claim 3. Ex. 1004, 2:5-9; Ex. 1001 ¶65. Thus, the broad disclosure of Beall would render obvious the composition recited in claim 3. Ex. 1001 ¶66-67.

Further, Beall’s Example 7 falls either within the numerical range of this composition or is within the numerical range as augmented by “about,” based upon Patent Owner’s assertion regarding the precision of “about.” Ex. 1004, 10:1-8; Ex. 1001 ¶68.

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The composition recited in claim 3 of the '451 patent, Beall Example 7, and Beall's disclosed ranges are included in the table below.

<i>'451 Patent Claim 3</i>	<i>Beall Example 7</i>	<i>Beall Ranges</i>
about 64 to about 70% SiO ₂	71.7%	65-80%
about 5.2 to about 9 Al ₂ O ₃	9.49%	0-11%
about 10 to about 15% Li ₂ O	9.47%	8-19%
about 2 to about 7% P ₂ O ₅	5.48%	1.5-7%
up to about 1.5% F	N/A	N/A
up to about 7% BaO	N/A	0-6%
up to about 1% SrO	N/A	0-6%
up to about 5% Cs ₂ O	N/A	N/A
up to about 5% K ₂ O	N/A	0-7%
up to about 2.7% B ₂ O ₃	N/A	N/A
up to about 0.9% CaO	1.08%	0-10%
up to about 3% Na ₂ O	N/A	0-5%
up to about 2% TiO ₂	N/A	N/A
up to about 3% ZrO ₂	2.49%	0-3%

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<i>'451 Patent Claim 3</i>	<i>Beall Example 7</i>	<i>Beall Ranges</i>
up to about 1% SnO ₂	N/A	N/A
up to about 1% Sb ₂ O ₃	N/A	N/A
up to about 3% Y ₂ O ₃	N/A	N/A
up to about 1% CeO ₂	N/A	N/A
up to about 1% Eu ₂ O ₃	N/A	N/A
up to about 1% Tb ₄ O ₇	N/A	N/A
up to about 2% Nb ₂ O ₅	N/A	N/A
up to about 2% Ta ₂ O ₅	N/A	N/A

The table above shows Beall disclosing ranges which overlap the claimed ranges, and the claimed ranges are indeed mostly subsumed in the prior art range. Although no specific Beall example falls precisely within the claimed range, Example 7 is very close. Ignoring the term “about,” only three components of Beall Example 7 are outside the specifically recited ranges: SiO₂ (71.7% outside about 64-70%), Al₂O₃ (9.49% outside about 5.2-9%), and CaO (1.08% outside up to about 0.9%). Ex. 1004, 10:1-8; Ex. 1001 ¶69.

For the same reasons discussed above with respect to claim 1, claim 3 also is *prima facie* obvious. *Peterson*, 315 F.3d at 1330. Here too, nothing suggests that

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the selected ranges of “about 64 to about 70% SiO₂,” “about 5.2 to about 9 Al₂O₃,” “about 10 to about 15% Li₂O,” and “about 2 to about 7% P₂O₅” lead to anything unexpected compared to the broader ranges disclosed in Beall. Similarly, claim 3 would have been obvious considering the closeness of Example 7 to the end points of the claimed ranges. *Titanium*, 778 F.2d at 783. A POSITA would expect Example 7 to have the same properties as a glass ceramic composition falling within the claimed ranges. Ex. 1001 ¶70.

Further, based upon Patent Owner’s construction for the term “about,” Beall Example 7 meets every limitation, as follows:

<i>Claim Limitation</i>	<i>Patent Owner Interpretation</i>	<i>Beall Example 7</i>
about 70% SiO ₂	68-72%	71.7%
about 9 Al ₂ O ₃	7-11%	9.49%
about 0.9%	0.7-1.1%	1.08%

Ex. 1001 ¶71.

Moreover, there is no evidence in the ’451 patent for the criticality of any of the claimed ranges for these components. *See* Ex. 1002; Ex. 1001 ¶72. Indeed, the disclosure of the ’451 patent suggests that the recited ranges are *not* critical. Ex. 1002, Table 1 (disclosing Ranges 1, 3, and 6 encompassing 71.7% of SiO₂, 9.49%

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of Al₂O₃, and 1.08% of Li₂O); Ex. 1001 ¶72. Accordingly, Beall Example 7 would render obvious the composition recited in claim 1. Ex. 1001 ¶74.

As discussed above with respect to claim 1, Beall does not include any additional components that would violate the “consisting essentially of” language of claim 3. In particular, although Beall discloses the potential presence of ZnO in the amount of 0-7%, (Ex. 1004, 2:5-9), (1) the range encompasses 0% ZnO and (2) the range is identical to that recited in claims 10 and 35 of the ’451 patent. Ex. 1002, 13:10-53,15:31-56; Ex. 1001 ¶73. Further, with respect to Example 7, every component of Example 7 is recited in claim 3. Ex. 1004, 10:1-8; Ex. 1001 ¶73.

Accordingly, Beall renders claim 3 unpatentable as obvious. Ex. 1001 ¶74.

VII. Ground 2 – Claims 2, 4, and 57-61 Are Unpatentable Over Petticrew in View of Beall

As discussed above, Beall alone renders obvious independent claims 1 and 3. Although Beall may not explicitly disclose the limitations of claims 2, 4, and 57-61, Petticrew in combination with Beall would have rendered obvious these claims. Ex. 1001 ¶81.

Applicants admitted that “dental restorations made from castable lithium disilicate glass-ceramics” existed in the prior art. Ex. 1002, 1:21-31. Petticrew discloses the use of lithium disilicate glass-ceramics for dental restorations and explicitly discloses using Beall’s compositions as dental restorations. Ex. 1003, 23;

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Ex. 1001 ¶82. And, as discussed above, Beall discloses the specific lithium disilicate glass-ceramic compositions and methods for making those glass-ceramics recited in the '451 patent. Ex. 1004, 9:6-10:26; Ex. 1001 ¶82.

A. Combining Petticrew With Beall Would Have Been Obvious

Explicit motivation to combine Petticrew with Beall is found in the prior art itself. Petticrew specifically refers to the Beall patent, stating “[o]ther lithium disilicate glass-ceramic materials which may be used in this invention are disclosed in U.S. Patent 5,219,799 issued June 15, 1993.” Ex. 1003, 23. Thus, there is “no question” that one of ordinary skill would be led to combine the two references. *Optivus Tech., Inc. v. Ion Beam Apps S.A.*, 469 F.3d 978, 990-91 (Fed. Cir. 2006) (Express mention of secondary reference in primary reference leaves “no question” that a POSITA would be led to combine the references.). Given Petticrew’s instructions to use the Beall composition as a dental restoration, it would have been at least obvious to a POSITA to try making a dental restoration from the compositions disclosed in Beall according to Petticrew’s procedures. Ex. 1001 ¶83. Further, a POSITA would have had a reasonable expectation of success in forming a dental restoration from any of Beall’s compositions using Petticrew’s process because Petticrew specifically teaches that “[l]ithium disilicate glass-ceramic materials are *particularly suited* for use in the invention” (Ex. 1003, 23) and Beall’s

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compositions are similar to those disclosed in Petticrew, particularly Tables I-III. Moreover, considering that the composition used in Example 15 of Petticrew is far different from those disclosed in Tables I-III and was shown to be able to form a dental restoration (*Id.*, 52-53), a POSITA would have reasonably expected that compositions similar to those disclosed in Tables I-III of Petticrew, such as Beall's compositions, would similarly be able to form dental restorations. Ex. 1001 ¶¶84-88.

The Beall compositions' utility for dental applications is further evidenced by Patent Owner's parent Ivoclar purchasing Beall from Corning and asserting it against Jeneric/Pentron's OPC 3G *pressable glass-ceramic dental restoration material*. Ex. 1007, *Ivoclar N. Am., Inc. v. Jeneric/Pentron Incorporated*, 2000 WL 35516146 (W.D.N.Y.), Complaint ¶¶7, 10-11; Ex. 1001 ¶89.

B. Dependent Claims 2 and 4

Claim 2 depends from claim 1 and adds "whereby the glass-ceramic is pressable." Ex. 1002, 12:9-10; Ex. 1001 ¶90. Claim 4 depends from claim 3 and adds "whereby the glass-ceramic is pressable." Ex. 1002, 12:39-40; Ex. 1001 ¶90.

Petticrew describes in detail the use of lithium disilicate glass-ceramics to form pressable dental restorations. Ex. 1001 ¶94. Dental restorations are discussed throughout Petticrew, including forming "metal free crowns and bridges of outstanding strength and esthetic properties" using the lithium disilicate

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compositions. Ex. 1003, 22; Ex. 1001 ¶94. Petticrew states:

the trade has recognized that in order to produce strong, translucent metal free dental restorations it would be desirable to form these restorations directly from a homogeneous molten glass-ceramic material. It was realized that it may be possible to ***produce a satisfactory restoration by forcing a molten or plastic glass-ceramic material into a mold having a cavity in the form of the desired dental restoration.*** The prior art further recognized that the glass-ceramic material could be introduced into the cavity when the glass-ceramic material was in the liquid or in the plastic state.

Ex. 1003, 3; Ex. 1001 ¶92. Petticrew explains: “the process of the subject invention utilizes a positive mechanically applied force for purposes of injecting the molten dental glass-ceramic material into the preformed mold cavity.” Ex. 1003, 6; Ex. 1001 ¶93. A POSITA would understand that Petticrew’s glass-ceramic compositions were pressable at least because of its explicit disclosure of forming dental restorations by pressing plastic glass-ceramic material into a mold. Ex. 1001 ¶94-95.

Thus, Petticrew discloses the limitations of claims 2 and 4. Ex. 1001 ¶96.

C. Claim 57

Claim 57 recites “[a] dental restoration comprising a glass-ceramic consisting essentially of” several components set forth in the table below. As shown, the first

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five limitations recite components that must be present in an amount “about” a recited range. Ex. 1002, 18:41-67; Ex. 1001 ¶97. The remaining several limitations recite additional components that may optionally be present in the composition “up to about” a certain weight percentage. Ex. 1002, 18:41-67; Ex. 1001 ¶97.

Beall discloses broad ranges for the claimed components that overlap the claimed ranges, as set forth in the table below. Ex. 1004, 2:5-9; Ex. 1001 ¶99. Thus, Beall discloses compositions with ranges of components that would render obvious the composition recited in claim 57. Ex. 1001 ¶99. Further, Beall’s Example 3 falls exactly within the numerical ranges of the composition of claim 57. Ex. 1004, 9:59-67; Ex. 1001 ¶98. Beall’s Example 3 does not contain any of the additional components recited in claim 57. Ex. 1004, 9:59-67; Ex. 1001 ¶98.

The composition recited in claim 57 of the ’451 patent, Beall Example 3, and the ranges of components disclosed in Beall are included in the table below: Ex. 1001 ¶100.

<i>’451 Patent Claim 57</i>	<i>Beall Example 3</i>	<i>Beall Ranges</i>
about 62 to about 85% SiO ₂ ;	74.2%	65-80%
about 1.5 to about 10% Al ₂ O ₃ ;	3.54%	0-11%
about 8 to about 19% Li ₂ O;	15.4%	8-19%

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<i>'451 Patent Claim 57</i>	<i>Beall Example 3</i>	<i>Beall Ranges</i>
about 2.5 to about 7% K ₂ O;	3.25%	0-7%
about 0.5 to about 12% P ₂ O ₅	3.37%	1.5-7%
up to about 4.9% B ₂ O ₃ ;	N/A	N/A
up to about 1.5% F;	N/A	N/A
up to about 7% CaO;	N/A	0-10%
up to about 7% BaO;	N/A	0-6%
up to about 1% SrO;	N/A	0-6%
up to about 5% Cs ₂ O;	N/A	N/A
up to about 5% Na ₂ O;	N/A	0-5%
up to about 2% TiO ₂ ;	N/A	N/A
up to about 3% ZrO ₂ ;	N/A	0-3%
up to about 1% SnO ₂ ;	N/A	N/A
up to about 1% Sb ₂ O ₃ ;	N/A	N/A
up to about 3% Y ₂ O ₃ ;	N/A	N/A
up to about 1% CeO ₂ ;	N/A	N/A

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<i>'451 Patent Claim 57</i>	<i>Beall Example 3</i>	<i>Beall Ranges</i>
up to about 1% Eu ₂ O ₃ ;	N/A	N/A
up to about 1% Tb ₄ O ₇ ;	N/A	N/A
up to about 2% Nb ₂ O ₅ ; and	N/A	N/A
up to about 2% Ta ₂ O ₅ .	N/A	N/A

The table above shows a prior art reference (Beall) disclosing a range which overlaps the claimed range, as well as a specific example falling within the claimed range.

For the same reasons discussed above with respect to claims 1 and 3, claim 57 also is *prima facie* obvious. *Peterson*, 315 F.3d at 1330. Here too, the applicants have not shown how the selected ranges of “about 62 to about 85% SiO₂,” “about 1.5 to about 10 Al₂O₃,” “about 8 to about 19% Li₂O,” “about 2.5 to about 5% K₂O,” and “about 0.5 to about 12% P₂O₅” lead to anything unexpected compared to the ranges disclosed in Beall. Ex. 1001 ¶101.

Regarding the “consisting essentially of” language of the preamble, Beall does not include any additional components that would violate the “consisting essentially of” language of claim 3. In particular, although Beall discloses the potential

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presence of ZnO in the amount of 0-7%, (Ex. 1004, 2:5-9), (1) the range encompasses 0% ZnO and (2) the range is identical to that recited in claims 10 and 35 of the '451 patent. Ex. 1002, 13:10-53,15:31; Ex. 1001 ¶102.

Although Beall explicitly discloses the glass-ceramic composition recited in claim 57, Beall does not explicitly disclose that its compositions are applicable to a “dental restoration” as stated in the preamble of claim 57. Ex. 1001 ¶103. However, Petticrew explicitly discloses that Beall’s compositions are indeed applicable to the field of dental restorations. *See* Ex. 1003, 23; Ex. 1001 ¶103.

Petticrew, entitled “Method for Molding Dental Restorations and Related Apparatus,” states:

[t]he present invention relates to a process for the molding of metal free dental restorations such as crowns, bridges, inlays, onlays, etc. from glass- ceramic materials. The invention is also concerned with apparatus which permits dental restorations to be easily molded from glass-ceramic materials and lastly, the invention relates to the resulting dental restorations.

Ex. 1003, 1. Given Petticrew’s explicit instructions to use Beall’s compositions as a dental restoration, it would have been at least obvious to a POSITA to try making a dental restoration from the Beall compositions according to the Petticrew procedures. *Id.*, 23 (“Other lithium disilicate glass-ceramic materials which may be

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used in this invention are disclosed in [Beall].”); Ex. 1001 ¶104. Further, as discussed above, a POSITA would have had a reasonable expectation of success in forming a dental restoration from any of Beall’s compositions using Petticrew’s process because Petticrew specifically teaches that “[l]ithium disilicate glass-ceramic materials are *particularly suited* for use in the invention (Ex. 1003, 23) and Beall’s compositions are similar to those disclosed in Petticrew, particularly Tables I-III. Moreover, considering that the composition used in Example 15 of Petticrew is far different from those disclosed in Tables I-III and was shown to be able to form a dental restoration (Ex. 1003, 52-53), a POSITA would have reasonably expected that compositions similar to those disclosed in Tables I-III of Petticrew, such as Beall’s compositions, would similarly be able to form dental restorations. Ex. 1001 ¶104.

Thus, this limitation would have been obvious over Petticrew in view of Beall. Ex. 1001 ¶105.

D. Dependent Claim 58

Claim 58 depends from claim 57 and adds the dental restoration “formed into a component selected from orthodontic appliances, bridges, space maintainers, tooth replacement appliances, splints, crowns, partial crowns, dentures, posts, teeth, jackets, inlays, onlays, facing, veneers, facets, implants, abutments, cylinders and

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connector.” Ex. 1002, 19:1-6; Ex. 1001 ¶106.

Petticrew specifically discloses:

[t]he present invention relates to a process for the molding of metal free dental restorations such as crowns, bridges, inlays, onlays, etc. from glass- ceramic materials.

Ex. 1003, 1; Ex. 1001 ¶107-8. Given Petticrew’s explicit instructions to use Beall’s compositions for a dental restoration, it would have been at least obvious to a POSITA try making a dental restoration from the Beall compositions according to the Petticrew procedures. Ex. 1003, 23; Ex. 1001 ¶109. Further, as discussed above, a POSITA would have had a reasonable expectation of success in forming the listed dental restorations from the Beall composition using the Petticrew process. Ex. 1001 ¶109.

Thus, this limitation would have been obvious over Petticrew in view of Beall. Ex. 1001 ¶110.

E. Dependent Claim 59

Claim 59 recites a “blank for machining the dental restoration of claim 57.” Ex. 1002, 19:7-8; Ex. 1001 ¶111.

Although neither Petticrew nor Beall contain an explicit description of machining a dental restoration, it would have been obvious to a POSITA to do so. Ex. 1001 ¶112.

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First, this feature is implicit in Beall's statement that the glass-ceramics can be "melted in large commercial melting units and formed into desired shapes via conventional glass melting and forming practice." Ex. 1004, 9:15-20, Ex. 1001 ¶113. A POSITA of glass-ceramics, looking at Beall at the time of the filing of the patent application for the '451 patent, would understand that a "conventional glass melting and forming practice" certainly includes forming a shape by grinding or machining. Ex. Ex. 1001 ¶113.

In particular, because Petticrew expressly teaches that Beall's compositions can be used to form dental restorations and it was well known in the art at the time that dental restorations may be formed by pressing or machining, it would be obvious for a POSITA to form Beall's compositions into a shape that is easy for machining. Ex. 1001 ¶114; I.L. Denry, "Recent Advances in Ceramics for Dentistry" Crit. Rev. Oral. Biol. Med. 7(21):134-143 (1996) at 138 (Ex. 1008) (disclosing glass-ceramics in forms for CAD-CAM systems); Ex. 1010, 5:24-27 ("[i]t is also possible to process the glass ceramic product in the form of a blank by machining in stage (d2), particularly by CAD/CAM-based milling devices, to obtain a glass ceramic product of the desired geometry"); and J. Robert Kelly, Ceramics in Dentistry: Historical Roots and Current Perspectives, The Journal of Prosthetic Dentistry, vol. 75, no. 1, pp. 18-32 (Jan. 1996) at 23-24 (Ex. 1011) (discussing machining as a "forming

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method in fabrication of ceramic restorations.”). Ex. 1001 ¶115.

Thus, this limitation would have been obvious in light of the disclosure in Petticrew and Beall. Ex. 1001 ¶116.

F. Dependent Claim 60

Claim 60 depends from claim 1 and recites “a dental restoration comprising the glass-ceramic of claim 1.” Ex. 1002, 19:9-10; Ex. 1001 ¶117.

As discussed above in Section VI.A, the composition recited in claim 1 is rendered obvious by the disclosure of Beall. As also discussed above with respect to claim 57 in Section VII.C, Beall does not explicitly disclose application of its compositions to dental restorations. However, Petticrew explicitly discloses using Beall’s compositions to form dental restorations. Ex. 1003, 23; Ex. 1001 ¶118. Accordingly, for the reasons discussed above, this limitation would have been obvious over Petticrew in view of Beall. Ex. 1001 ¶119.

G. Claim 61

Claim 61 recites “[a] dental restoration comprising the glass-ceramic composition comprising” several components set forth in the table below. Ex. 1002, 19:11-16; Ex. 1001 ¶120.

The ranges of components disclosed in Beall overlap with the claimed ranges recited in claim 61, rendering the recited ranges obvious. Ex. 1004, 2:5-9; Ex. 1001 ¶122. Further, Beall Example 4 falls exactly within the numerical ranges recited in

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claim 61. Ex. 1004, 9:59-10:7; Ex. 1001 ¶121. Moreover, claim 61 recites the open-ended transitional term “comprising” rather than “consisting essentially of,” which accordingly does not prohibit the presence of additional components beyond those recited in the claim. So it does not matter that there is ZrO₂ or CaO or any other component present in Example 4 of Beall. Ex. 1001 ¶122.

The composition recited in claim 61 of the '451 patent, Beall Example 4, and the ranges of components disclosed in Beall are included in the table below. Ex. 1001 ¶123.

<i>'451 Patent Claim 61</i>	<i>Beall Example 4</i>	<i>Beall Ranges</i>
about 64 to about 70% SiO ₂	68.6%	65-80%
about 5.2 to about 9 Al ₂ O ₃	8.56%	0-11%
about 10 to about 15% Li ₂ O	11.2%	8-19%
about 2 to about 7% P ₂ O ₅	4.18%	1.5-7%

As detailed above, Petticrew explicitly instructs a POSITA to use Beall's compositions in the formation of a dental restoration. Ex. 1003, 23; Ex. 1001 ¶124. Thus, it would have been at least obvious to a POSITA to try making a dental restoration from the Beall compositions according to the Petticrew procedures. Ex. 1003, 23; Ex. 1001 ¶1124. Further, as discussed above in Section VII.A, a POSITA

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would have had a reasonable expectation of success in forming the listed dental restorations from any of the Beall compositions using the Petticrew process. Ex. 1001 ¶124.

Thus, this limitation would have been obvious over Petticrew in view of Beall. Ex. 1001 ¶125.

VIII. Ground 3 – Claim 3 Is Unpatentable Over Echeverria

Echeverria would have rendered obvious the recited glass-ceramic compositions of claim 3. Ex. 1001 ¶80.

Claim 3 recites “a glass-ceramic consisting essentially of in weight percent” followed by a list of several components set forth in the table below. Four components must be present while the remaining several limitations are optional components. Ex. 1002, 12:11-38; Ex. 1001 ¶75.

Echeverria’s Example E falls either within the numerical range of this composition or is within the numerical range as augmented by “about,” based upon Patent Owner’s assertion regarding the precision of “about.” Ex. 1005, 184; Ex. 1001 ¶76.⁴

⁴ Echeverria, like Beall, discloses numerous lithium disilicate glass ceramic compositions. While the two references have overlapping disclosures, they are not

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The composition recited in claim 3 of the '451 patent, and Echeverria Example E, are shown in the table below. Ex. 1001 ¶77.

<i>'451 Patent Claim 3</i>	<i>Echeverria Example E</i>
about 64 to about 70% SiO ₂	68.6%
about 5.2 to about 9 Al ₂ O ₃	8.56%
about 10 to about 15% Li ₂ O	11.2%
about 2 to about 7% P ₂ O ₅	4.18%
up to about 1.5% F	N/A
up to about 7% BaO	N/A
up to about 1% SrO	N/A
up to about 5% Cs ₂ O	N/A
up to about 5% K ₂ O	0%

identical and certain compositions of Echeverria are even closer to the compositions claimed in the '451 patent when compared to the compositions of Beall. For example, Example E in Echeverria falls almost if not entirely within the explicit range of claim 3 (only CaO with 1.01% could possibly be argued to be outside the claimed “up to about 0.9%” range).

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<i>'451 Patent Claim 3</i>	<i>Echeverria Example E</i>
up to about 2.7% B ₂ O ₃	N/A
up to about 0.9% CaO	1.01%
up to about 3% Na ₂ O	N/A
up to about 2% TiO ₂	N/A
up to about 3% ZrO ₂	2.01%
up to about 1% SnO ₂	N/A
up to about 1% Sb ₂ O ₃	N/A
up to about 3% Y ₂ O ₃	N/A
up to about 1% CeO ₂	N/A
up to about 1% Eu ₂ O ₃	N/A
up to about 1% Tb ₄ O ₇	N/A
up to about 2% Nb ₂ O ₅	N/A
up to about 2% Ta ₂ O ₅	N/A

There is only one component of Example E outside the strict numerical ranges of claim 3: CaO. Ex. 1005, 184; Ex. 1001 ¶78. Echeverria Example E discloses

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CaO in an amount of 1.01%, which is within the range of “approximately 0.9%,” following Patent Owner’s construction of “about.” Ex. 1005, 184; Ex. 1001 ¶78. Further, claim 3 would have been obvious considering the closeness of Example E to the end points of the claimed ranges. *Titanium*, 778 F.2d at 783. A POSITA would expect Example E to have the same properties as a glass ceramic composition falling within the claimed ranges. Ex. 1001 ¶79. Echeverria provides ample motivation or suggestion to a POSITA to adjust a glass-ceramics composition within the ranges stated in the article. Ex. 1005, 187. Echeverria’s Example E discloses a composition that is within the exact numerical ranges of claim 3, with the only exception being 1.01% CaO. One of ordinary skill in the art would consider the range for CaO described later in Echeverria (“CaO 0-5 wt%”). Ex. 1005, 187.

Echeverria renders claim 3 unpatentable as obvious. Ex. 1001 ¶80.

IX. Ground 4 - Claims 4, 57-59, and 61 Are Unpatentable Over Petticrew in View of Echeverria

As discussed above, Echeverria renders obvious independent claim 3. Although Echeverria may not explicitly disclose the limitations of claims 4, 57-59, and 61, Petticrew in combination with Echeverria would have rendered obvious these claims. Ex. 1001 ¶126.

A. Combining Petticrew With Echeverria Would Have Been Obvious

The disclosure of Petticrew itself suggests that Echeverria’s compositions

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could easily be used in Petticrew's disclosed methods. Ex. 1001 ¶127. Petticrew teaches that lithium disilicate glass-ceramic materials are the preferred glass-ceramic materials for use in the disclosed method. See Exhibit 1003, 25 ("As is shown in Table I to IV *preferred glass-ceramic materials for use in this invention are lithium disilicate glass- ceramic materials. . . . Lithium disilicate glass-ceramic materials are particularly suited for use in the invention . . .*")(emphasis added). Thus, Petticrew specifically instructs a POSITA that lithium disilicate glass-ceramics, such as those disclosed in Echeverria, are the preferred materials for use in Petticrew's methods.

Further, a POSITA would have had a reasonable expectation of success in forming a dental restoration from any of Echeverria's compositions using the Petticrew process because Petticrew specifically teaches that "[l]ithium disilicate glass-ceramic materials are *particularly suited* for use in the invention" (Ex. 1003, 23) and Echeverria's compositions are similar to those disclosed in Petticrew, particularly Tables I-III. Moreover, considering that the composition used in Example 15 of Petticrew is far different from those disclosed in Tables I-III and was shown to be able to form a dental restoration (*Id.*, 52-53), a POSITA would have reasonably expected that compositions similar to those disclosed in Tables I-III of Petticrew, such as Echeverria's compositions, would similarly be able to form dental

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restorations.. Ex. 1001 ¶128.

As noted above, the Beall compositions' utility for dental applications is further evidenced by Patent Owner's parent Ivoclar purchasing Beall from Corning and asserting it against Jeneric/Pentron's OPC 3G pressable glass-ceramic dental restoration material. Ex. 1007 at ¶¶7, 10-11; Ex. 1001 ¶89. Echeverria's compositions are similarly useful. Ex. 1001 ¶127.

B. Dependent Claim 4

Claim 4 depends from claim 3 and adds “whereby the glass-ceramic is pressable.” Ex. 1002, 12:39-40; Ex. 1001 ¶129.

For the same reasons discussed above in Section VII.B, Petticrew discloses the use of pressable glass-ceramic compositions for pressing into the form of dental restorations. *See* Ex. 1001 ¶90-96, 132.

Further, Echeverria discloses “[t]he low viscosity and liquidus simplified delivery and forming of these glasses, and allows diverse forming techniques.” Ex. 1005, 184; Ex. 1001 ¶130. Echeverria also discloses that “[t]he precursor glasses have low viscosities, and are amenable to a variety of forming techniques.” Ex. 1005, 187; Ex. 1001 ¶130.

A POSITA of glass-ceramics at the time of the filing of the application for the '451 patent would have understood that a composition that is amenable to

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“diverse forming techniques” and “a variety of forming techniques” would be able to be formed through pressing using commercially available equipment. Ex. 1005, 184, 187); Ex. 1001 ¶131. A POSITA would have known that at least from Petticrew. Ex. 1001 ¶131.

Accordingly, Petticrew and Echeverria disclose the limitation of claim 4. Ex. 1001 ¶133.

C. Claim 57

Claim 57 recites a “dental restoration comprising a glass-ceramic consisting essentially of” several components set forth in the table below. The first several components must be present in a certain range while the remaining limitations may optionally be present up to a recited amount. Ex. 1002, 18:41-67, Ex. 1001 ¶134.

Echeverria’s Example D falls exactly within the numerical range of this composition. Ex. 1005, 184; Ex. 1001 ¶135. Echeverria’s Example D does not contain any of the additional components recited in claim 57. Ex. 1001 ¶135

The composition recited in claim 57 of the ’451 patent and Example D are included in the table below: Ex. 1001 ¶136.

<i>’451 Patent Claim 57</i>	<i>Echeverria Example D</i>
about 62 to about 85% SiO ₂	74.2%
about 1.5 to about 10% Al ₂ O ₃	3.54%

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<i>'451 Patent Claim 57</i>	<i>Echeverria Example D</i>
about 8 to about 19% Li ₂ O	15.4%
about 2.5 to about 7% K ₂ O	3.25%
about 0.5 to about 12% P ₂ O ₅	3.37%
up to about 4.9% B ₂ O ₃	N/A
up to about 1.5% F	N/A
up to about 7% CaO	N/A
up to about 7% BaO	N/A
up to about 1% SrO	N/A
up to about 5% Cs ₂ O	N/A
up to about 5% Na ₂ O	N/A
up to about 2% TiO ₂	N/A
up to about 3% ZrO ₂	N/A
up to about 1% SnO ₂	N/A
up to about 1% Sb ₂ O ₃	N/A
up to about 3% Y ₂ O ₃	N/A

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<i>'451 Patent Claim 57</i>	<i>Echeverria Example D</i>
up to about 1% CeO ₂	N/A
up to about 1% Eu ₂ O ₃	N/A
up to about 1% Tb ₄ O ₇	N/A
up to about 2% Nb ₂ O ₅	N/A
up to about 2% Ta ₂ O ₅ .	N/A

With regard to the recitation of a “dental restoration” in claim 57’s preamble, it would have been obvious to a POSITA to form a dental restoration from Echeverria’s compositions in view of Petticrew. Ex. 1001 ¶137. Petticrew, which is entitled “Method for Molding Dental Restorations and Related Apparatus,” (Ex. 1003 at Title) states:

[t]he present invention relates to a process for the molding of metal free dental restorations such as crowns, bridges, inlays, onlays, etc. from glass- ceramic materials. The invention is also concerned with apparatus which permits dental restorations to be easily molded from glass-ceramic materials and lastly, the invention relates to the resulting dental restorations.

Ex. 1003, 1. As discussed in Section IX.A, it would have been obvious to use Echeverria’s compositions to form dental restorations in accordance with

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Petticrew's disclosure. Ex. 1001 ¶127-128.

Thus, Petticrew in view of Echeverria renders obvious the composition of claim 57. Ex. 1001 ¶138.

D. Dependent Claim 58

Claim 58 depends from claim 57 and adds the dental restoration "formed into a component selected from orthodontic appliances, bridges, space maintainers, tooth replacement appliances, splints, crowns, partial crowns, dentures, posts, teeth, jackets, inlays, onlays, facing, veneers, facets, implants, abutments, cylinders and connector." Ex. 1002, 19:1-6; Ex. 1001 ¶139.

As noted above, Petticrew specifically discloses

[t]he present invention relates to a process for the molding of metal free dental restorations such as crowns, bridges, inlays, onlays, etc. from glass- ceramic materials.

Ex. 1003, 1. As discussed in Section IX.A, it would have been obvious to use Echeverria's compositions to form the dental restorations listed in claim 58 in accordance with Petticrew's disclosure. Ex. 1001 Ex. 1001 ¶¶127-28,140-42.

Thus, Petticrew in view of Echeverria renders obvious the composition of claim 58. Ex. 1001 ¶143.

E. Dependent Claim 59

Claim 59 recites a "blank for machining the dental restoration of claim 57."

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Ex. 1002, 19:78; Ex. 1001 ¶144.

Although neither Petticrew nor Echeverria contain an explicit description of machining a dental restoration from a blank, it would have been obvious to a POSITA to do so. Ex. 1001 ¶145.

First, Echeverria discloses that its compositions are useful in a variety of forming techniques. Ex. 1005, at 187; Ex. 1001 ¶146. A POSITA of glass-ceramics, looking at Echeverria at the time of the filing of the patent application for the '451 patent, would have understood that a “variety of forming techniques” certainly includes forming a shape by machining. Ex. 1005, at 187; Ex. 1001 ¶146; Ex. 1008, at 138 (disclosing lithium disilicate glass-ceramics as machinable glass-ceramics desirable in the dental industry in 1996); Ex. 1010, 5:24-27; Ex. 1011 at 23-24.

Second, Petticrew expressly teaches that “[l]ithium disilicate glass-ceramic materials are *particularly suited* for use in the invention” (Ex. 1003, 23) and explicitly states that the Beall compositions—which are similar to the Echeverria compositions—can be used to form dental restorations, and it was well known in the art at the time that dental restorations may be formed by pressing or machining, so it would be obvious for a POSITA to form Echeverria’s compositions into a shape that is easy for machining. Ex. 1001 ¶147; Ex. 1008, 138; Ex. 1010, 5:24-27 (“[i]t is also possible to process the glass ceramic product in the form of a blank by

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machining in stage (d2), particularly by CAD/CAM-based milling devices, to obtain a glass ceramic product of the desired geometry”); Ex. 1011, 23-24 (discussing machining as a “forming method in fabrication of ceramic restorations.”); Ex. 1001 ¶148.

Thus, this limitation would have been obvious in light of the disclosure in Petticrew and Echeverria. Ex. 1001 ¶149.

F. Claim 61

Claim 61 recites a “dental restoration comprising the glass-ceramic composition comprising” several components set forth in the table below. Ex. 1002, 19:11-12. Ex. 1001 ¶150.

The ranges of components disclosed in Echeverria overlap with the claimed ranges recited in claim 61, rendering the recited ranges obvious. Ex. 1005, 187; Ex. 1001 ¶151. Further, Echeverria Example E falls exactly within the numerical ranges recited in claim 61. Ex. 1005, 184; Ex. 1001 ¶151. Moreover, claim 61 recites the open-ended transitional term “comprising” rather than “consisting essentially of,” which accordingly does not prohibit the presence of additional components beyond those recited in the claim.

The composition recited in claim 61 of the ’451 patent, Echeverria Example E, and the ranges disclosed in Echeverria are included in the table below: ¶152.

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<i>'451 Patent Claim 61</i>	<i>Echeverria Example E</i>	<i>Echeverria Ranges</i>
about 64 to about 70% SiO ₂	68.6% SiO ₂	65-80%
about 5.2 to about 9 Al ₂ O ₃	8.56% Al ₂ O ₃	0-10%
about 10 to about 15% Li ₂ O	11.2% Li ₂ O	8-17%
about 2 to about 7% P ₂ O ₅	4.18% P ₂ O ₅	1-5%

As discussed in Section IX.A, it would have been obvious to use Echeverria's compositions to form dental restorations, as recited in claim 61's preamble, in accordance with Petticrew's disclosure. Ex. 1001 ¶¶127-28,153.

Thus, this limitation would have been obvious over Petticrew in view of Echeverria. Ex. 1001 ¶154.

X. Mandatory Notices Pursuant to 37 C.F.R. §42.8(a)(1)

Pursuant to 37 C.F.R. §42.8(a)(1), the mandatory notices identified in 37 C.F.R. §42.8(b) are provided below as part of this Petition.

A. C.F.R. §42.8(b)(1): Real Parties-In-Interest

GC Corporation and GC America, Inc. are the real parties-in-interest for Petitioner.

B. C.F.R. §42.8(b)(2): Related Matters

The '451 patent is currently the subject of patent infringement lawsuits listed

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below. Additionally, other patents related to the '451 patent are (or have been) at issue in these cases:

- *Ivoclar Vivadent AG v. GC America Inc.*, No. 1:17-cv-02083 (N.D. Ill.)
- *In the Matter of Certain Dental Ceramics, Products Thereof, and Methods of Making the Same*, Inv. No. 337-TA-1050, U.S. International Trade Commission.

In addition, a petition for *inter partes* review of related U.S. Patent No. 6,802,894 is being filed concurrently with this petition.

C. C.F.R. §42.8(b)(3) and (4): Lead and Back-up Counsel and Service Information

Petitioner provides the following designation of counsel:

Lead Counsel	Back-up Counsel
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Pursuant to 37 C.F.R. §42.10(b), Powers of Attorney accompany this Petition. Please address all correspondence to lead and back-up counsel at the addresses above. Petitioner also consents to electronic service by email at the email addresses

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listed above.

XI. Conclusion

Petitioner has established a reasonable likelihood of prevailing with respect to claims 1-4 and 57-61. Petitioner therefore requests that the Patent Office order an IPR trial and then cancel claims 1-4 and 57-61.

Respectfully submitted,

Date: /April 17, 2018/ By /Carrie A. Beyer/

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 6,455,451, including all Exhibits and the Power of Attorney, was served on April 17, 2018 via FedEx delivery directed to the attorney of record for the patent at the following address:

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Date: /April 17, 2018/ By /Carrie A. Beyer /

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CERTIFICATE OF WORD COUNT UNDER 37 C.F.R. §42.24(a)

I, the undersigned, do hereby certify that the attached Petition, including footnotes, contains 10,483 words, as measured by the Word Count function of Word 2007. This is less than the limit of 14,000 words as specified by 37 C.F.R. §42.24(a)(i).

Date: /April 17, 2018/

By: /Carrie A. Beyer /

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PETITIONER’S EXHIBIT LIST

EXHIBIT NO.	TITLE
1001	Declaration of Arthur E. (“Buddy”) Clark
1002	U.S. Patent No. 6,455,451 (“the ’451 patent”)
1003	International Publication No. WO 95/32678 (“Petticrew”)
1004	U.S. Patent No. 5,219,799 (“Beall”)
1005	L. M. Echeverria, <i>New Lithium Discilicate-Glass Ceramics</i> , Bol. de la Soc. Esp. de Ceramica, 183:188, 1992
1006	Prosecution History of the ’451 patent
1007	<i>Ivoclar N. Am., Inc. v. Jeneric/Pentron Incorporated</i> , 2000 WL 35516146 (W.D.N.Y.) Complaint
1008	Isabelle L. Denry, <i>Recent Advances in Ceramics for Dentistry</i> , Crit. Rev. Oral Biol. Med., vol 7, no. 2, pp. 134-43 (Apr. 1, 1996)
1009	Staff’s Opening Statement Demonstrative Exhibit, US ITC Inv. No. 337-TA-1050 (excerpt)
1010	U.S. Patent No. 6,420,288 (“Schweiger ’288”)
1011	J. Robert Kelly, <i>Ceramics in Dentistry: Historical Roots and Current Perspectives</i> , The Journal of Prosthetic Dentistry, vol. 75, no. 1, pp. 18-32 (Jan. 1996).

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APPENDIX – CLAIM LISTING

1. A glass-ceramic composition consisting essentially of in weight percent:

about 64 to about 70% SiO₂;

about 1.5 to about 6% Al₂O₃;

about 10 to about 15% Li₂O;

about 2.5 to about 5% K₂O;

about 2 to about 7% P₂O₅;

up to about 1.5% F;

up to about 7% BaO;

up to about 1% SrO;

up to about 5% Cs₂O;

up to about 2.7% B₂O₃;

up to about 0.9% CaO;

up to about 3% Na₂O;

up to about 2% TiO₂;

up to about 3% ZrO₂;

up to about 1% SnO₂;

up to about 1% Sb_2O_3 ;

up to about 3% Y_2O_3 ;

up to about 1% CeO_2 ;

up to about 1% Eu_2O_3 ;

up to about 1% Tb_4O_7 ;

up to about Nb_2O_5 ; and

up to about 2% Ta_2O_5 .

2. The glass-ceramic composition of claim 1 whereby the glass-ceramic is pressable.

3. A glass-ceramic composition consisting essentially of in weight percent:

about 64 to about 70% SiO_2 ;

about 5.2 to about 9 Al_2O_3 ;

about 10 to about 15% Li_2O ;

about 2 to about 7% P_2O_5 ;

up to about 1.5% F

up to about 7% BaO ;

up to about 1% SrO ;

up to about 5% Cs_2O ;

up to about 5% K_2O ;

up to about 2.7% B_2O_3 ;
up to about 0.9% CaO ;
up to about 3% Na_2O ;
up to about 2% TiO_2 ;
up to about 3% ZnO_2 ;
up to about 1% SnO_2 ;
up to about 1% Sb_2O_3 ;
up to about 3% Y_2O_3 ;
up to about 1% CeO_2 ;
up to about 1% Eu_2O_3 ;
up to about 1% Tb_4O_7 ;
up to about 2% Nb_2O_5 ; and
up to about 2% Ta_2O_5 .

4. The glass-ceramic composition of claim 3 whereby the glass-ceramic is pressable.

57. A dental restoration comprising a glass-ceramic consisting essentially of:

about 62 to about 85% SiO_2 ;
about 1.5 to about 10% Al_2O_3 ;
about 8 to about 19% Li_2O ;

about 0.5 to about 12% P_2O_5 ;

up to about 4.9% B_2O_3 ;

up to about 1.5% F;

up to about 7% CaO;

up to about 7% BaO;

up to about 1% SrO;

up to about 5% Cs_2O ;

up to about 5% Na_2O ;

up to about 2% TiO_2 ;

up to about 3% ZrO_2 ;

up to about 1% SnO_2 ;

up to about 1% Sb_2O_3 ;

up to about 3% Y_2O_3 ;

up to about 1% CeO_2 ;

up to about 1% Eu_2O_3 ;

up to about 1% Tb_4O_7 ;

up to about 2% Nb_2O_5 ; and

up to about 2% Ta_2O_5 .

58. The dental restoration of claim 57 formed into a component selected from orthodontic appliances, bridges, space maintainers, tooth replacement

appliances, splints, crowns, partial crowns, dentures, posts, teeth, jackets, inlays, onlays, facing, veneers, facets, implants, abutments, cylinders, and connector.

59. A blank for machining the dental restoration of claim 57.

60. A dental restoration comprising the glass-ceramic of claim 1.

61. A dental restoration comprising the glass-ceramic composition comprising:

about 64 to about 70% SiO_2 ;

about 5.2 to about 9% Al_2O_3 ;

about 10 to about 15% Li_2O ;

about 2 to about 7% P_2O_5